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Home-Produced Alcohol

THE question of home production of alcohol has been to the fore since the introduction of the Budget. Alcohol producers appear to have a grievance in that they were encouraged to put up factories on the promise of Government support and this support appears to have been withdrawn almost immediately. The production of alcohol in this country has increased considerably within recent years. Between 1931 and 1937, the amount of alcohol mixed with petrol has risen from 18,331 gallons to 6,369,758 gallons. We believe that there are ten large distilleries now engaged wholly in the manufacture of power alcohol. The deliberations of the Inter-departmental Committee which examined the production of industrial alcohol in 1918 resulted in an allowance being made for the home-produced product, with the object of stimulating possible production from raw materials grown in this country.

It is said that much, and perhaps most, of the power alcohol made here is derived from imported molasses and that the taxation has been increased because the original object is not being achieved. The position is that the tax is now fixed at 9d. a gallon, but that $8\frac{3}{4}$d. a gallon can be recovered by the producers and/or the vendors. During the past financial year the Exchequer has lost £444,555 on the alcohol produced, of which sum rather less than half was due to exemption from the petrol tax, and rather more than half to the bounty. Sir Richard Acland, M.P., has stated that the principle of the bounty is just, since an industry which is penalised by Government regulations receives compensation accordingly. "But," he adds, "if, owing to some change of circumstances to which the law is not adapted, it can be suspected of receiving more than compensation, then public curiosity can reasonably be aroused. The recent profits of the company most concerned in blending alcohol with petrol certainly give grounds for this suspicion."

It seems unwise to argue that because the operations of a marketing organisation mixing a comparatively small proportion of alcohol with petrol are financially successful, the operation of manufacturing the alcohol is equally remunerative. There is probably every justification for importing molasses for alcohol production, one of these being the higher yield obtainable. Admittedly, the national liquid fuel policy of nearly every nation to-day is to rely on home sources of raw materials, and on that ground it would be preferable to make alcohol in this country from materials containing starch or sugar grown here. One difficulty is the low yield. Published figures show that whereas sugar molasses yield 62 gallons of 99.9 per cent. alcohol per ton, sugar beet yields only 17 gallons and potatoes 20 gallons. The suggestion has been heard of late that the effort made 30 years ago to introduce large-scale production of power and industrial alcohol from indigenous material should be revived, the idea to-day being to grow very large acreages of potatoes which can be turned into alcohol in times of peace and used for food in times of war. It has been stated that the earlier attempt failed because the Excise would not reduce the duty on the alcohol so produced, engine makers would not adapt their engines to use alcohol, and farmers would not grow the potatoes unless they were assured of a market. Even if all these conditions could be fulfilled to-day, it does not seem in the least likely that the project would succeed.

The price of alcohol for power purposes—and this must be the major market—is governed by that of petrol. A report on the subject issued in New Zealand in 1935 showed that the price of petrol delivered at the docks was 5d., the distribution, etc., charges were $6\frac{1}{2}$d., and the tax was $10\frac{1}{2}$d., a total of 1s. 10d. The cost of growing potatoes was about £3 14s. a ton. In order to sell power alcohol at 2s. a gallon, even if the alcohol was duty-free, the price that could be paid for potatoes was about £1 a ton. Clearly the economic factor is heavily weighted against home production of alcohol, and the farmer might do better by using his extra potatoes for feeding pigs. The total cost of petrol in this country is probably something like this: Price at docks, $3\frac{1}{2}$d. to 4d.; distribution, 2d.; tax, 9d.; total, 1s. 3d.—much less than the New Zealand figure, so that even if duty-free nothing like £1 could be paid for the potatoes.

In Germany in 1934 some 75,000,000 gallons of industrial alcohol were produced, of which 50,000,000 came from potatoes. Allowing 20 gallons of alcohol per ton of potatoes, this accounts for only 6 per cent. of Germany's potato crop; obviously only the rejects are used for the purpose.

To this day even on the boards of companies which are directly exploiting the results of scientific developments, those who have been very largely responsible for those developments are not included. The technical man is still kept in his place. In fact it is only through their own force of character that men of science and technical men have shared in the control of affairs.

—Professor A. C. G. Egerton.

Notes and Comments

Solvents and Plasticisers

THE last decade has seen a wide expansion, certainly greater than that of any other period in the history of the solvents industry, in the range of solvents and plasticisers available to the chemical and allied trades. The progressive research of the solvent manufacturers towards new and improved products has, of course, been directly responsible for the expansion and their efforts received a most valuable stimulus from the enormous developments made during this time by the cellulose lacquer industry, the largest solvent-using group of manufacturers. New synthetic resins and cellulose derivatives, for example, ethyl cellulose and cellulose acetobutyrate, have been introduced and have been found to have promising applications as film-forming materials. Before such applications can be utilised commercially, suitable solvents for the materials have to be found together with suitable plasticisers for softening the film formed on evaporation of the mixture. In many cases solvents and plasticisers already well known can be selected as being suitable for the new film bases but in others entirely new compounds have to be sought, especially when plasticisers are being considered. Thus the task of selecting the most convenient solvent or plasticiser for the purpose in mind would appear to have become more formidable owing to the greatly increased number of materials on the market, but the information supplied by the manufacturers as to the scope of application of any particular material is generally most comprehensive and greatly facilitates selection. The present issue contains details of some of the solvents and plasticisers on the market and of methods of solvent recovery, a very necessary provision where manufacturing operations involve evaporation of solvents to any considerable extent.

Last Month's Trade Returns

ALTHOUGH the overseas trade returns for May show increases in imports, exports and re-exports over the previous month, as against May, 1937, however, there was a total decline of slightly over £12½ millions. This total is made up of a fall in imports of about £7¾ millions, in exports of £4½ millions, and in re-exports of £¼ million. Foreign trade in chemicals has suffered similarly with a fall in imports over the previous May of £112,400, in exports of £243,768 and in re-exports of £1,300. The reason for the unsatisfactory position is generally agreed to be due to the fall in commodity values. Be that as it may, it is quite certain that, with other countries undergoing a similar decrease in their foreign trade, the only efficacious method of increasing overseas commerce is by trade agreements. Industry can, therefore, only regard with satisfaction the activity with which this country is pursuing that course of solving the problem. The delay involved in the conclusion of the Anglo-American agreement has been the subject of discussion between the Board of Trade and the Australian Trade Delegation with the object not only of speeding-up the negotiations but also of considering a three-cornered agreement between the United States, the Dominions, and Great Britain.

Labour Party View of Oil from Coal Production

AN advisory committee of the Labour Party published this week a report on the production of oil from coal. From an examination of the position of the coal industry, and of the costs of producing oil from coal, and of importing it, development of a coal-oil industry is recommended. It is suggested that one new hydrogenation plant, six plants operating the synthetic process, and five low-temperature carbonisation plants should be set up by the State either alone or in conjunction with private enterprise. The total cost of the new plants is estimated at about £17¾ millions with an annual output of slightly above 100 million gallons of motor spirit. It is also recommended that the financial resources of the Fuel Research Station be substantially increased to enable a bigger programme of research to be undertaken. It is explained that the report was completed before the Falmouth report (which considered that importation of oil and storage sufficient for an emergency but recommended the continuance of the preference on home-produced spirit as an inducement to industry) was made public. The proposals of the Labour Party report seem to go for the problem like a bull at a gate; it would surely be more satisfactory for the State to help finance a large-scale operation of a synthetic process and compare the results obtained with those of the other processes, rather than to embark on such an ambitious programme without the necessary experience.

Testing the Viscosity of Celluloses

VISCOSITY measurements for solutions of cellulose in cuprammonium hydroxide form one of the standard methods of determining the quality of the cellulose and the extent of its degradation, thus giving information regarding the suitability of the cellulose for the manufacture of artificial silk, films and cellulose lacquers. In a paper to the 15th National Colloid Symposium of the American Chemical Society, Dr. A. J. Stamm and W. E. Cohen show that these viscosity measurements are complicated by the fact that it is difficult to make the solvent of the same composition for each determination and the length of time to which the solution is exposed to the air also greatly affects the measurements. The authors have developed a technique for carrying out the measurements in solution in phosphoric acid. The weight and length of the cellulose molecule is determined from the viscosity value obtained by passing the phosphoric acid solution through a capillary tube, the solution being of such dilution that the molecules do not interfere with one another. The velocity of the hydrolysis of cellulose in concentrated phosphoric acid can be estimated by taking viscosity measurements at different times during which the cellulose has been in solution.

Progress in the Road Tar Industry

AT the International Road Tar Conference at Scheveningen on Monday, Professor H. Mallison presented a review of the achievements which have been made in the rapid development of the road tar industry since the opening of the century and of the extent to which the properties of road tar of economic and technical importance are responsible for this and future progress. The realisation that crude tar was a valuable source of raw materials resulted in the application of distillation and working up methods which has now been so widely carried out that almost all the crude tar produced is distilled. Useful outlets for pitch, contained in tar in a proportion of about 50 per cent., have now been devised. Owing to the co-operation of the chemists and engineers, a road binding material has been evolved which gives a resisting road covering in addition to a protective coating. Professor Mallinson pointed out that it was satisfactory to see that tar was becomnig a standardised material.

Solvents: Some Interesting Uses*

The Lower Aliphatic Alcohols, Esters and Ketones

THE word "solvent" covers a multitude of chemical substances from water, the most widely used of all solvents, to highly complex synthetic organic compounds prepared for special purposes. To-day, however, when we talk of solvents, we think of certain well-defined groups which are applied to specific purposes. This article will be confirmed to a survey of the group which includes the lower aliphatic alcohols, their various esters, and the ketones chemically related to these alcohols.

The last ten years has seen a rapid growth in the demand for this group of solvents. Before that time a number of them were only known as laboratory specimens, and had no industrial applications. Some, it is true, were available on a commercial scale as by-products of the destructive distillation of wood for the preparation of charcoal. From this old-fashioned and wasteful process it is only a short step in time, but a long one in chemistry, to the modern highly-efficient synthetic processes for the production of solvents of the highest purity, in quantities sufficient to meet the demands of many industries.

Before considering the many industrial processes in which this group of solvents is used, something may be said regarding the relationship of the members of the group. The true raw materials are molasses and yeast, although this is really going one stage too far back. Molasses is fermented to give ethyl alcohol; fusel oil, with its valuable amyl and iso butyl alcohol content, is obtained as a by-product. By two different synthetic processes ethyl alcohol is converted into acetone and acetaldehyde, acetaldehyde being the half-way stage to both acetic acid and butyl alcohol. By combination of these alcohols, ethyl, iso butyl, norm l butyl and amyl, with acetic acid and other organic acids or anhydrides, we get, for example, acetates, phthalates, tartrates, stearates and oleates which are all industrially useful either as solvents or plasticisers.

Three Types of Solvents for Cellulose

The greatest factor in the development of the synthetic solvents industry has been the demand for various types of solvents and plasticisers for nitrocellulose and other cellulose esters and ethers. The cellulose compounds were found to give very fine quick-drying lacquers which could be used for many purposes, from furniture and automobile lacquers to nail varnishes and printing ink.

One of the largest outlets for these solvents and plasticisers is in the paint, varnish and lacquer industry. For the manufacture of nitrocellulose and cellulose acetate lacquers, three types of solvents are required, depending on the specific purpose for which the lacquer is intended. The three types are: solvents of low boiling point and consequently high rate of evaporation, such as acetone, methyl and ethyl acetates; medium boiling solvents, for example butyl acetate; and high boiling solvents such as ethyl lactate and diacetone alcohol.

For some purpose, lacquers must be very quick-drying. For example, modern cheap furniture lacquering is a one coat job which must dry in 10 to 15 minutes. On the other hand, brushing lacquers must dry more slowly so that brush marks may have time to flow out. In this case a higher proportion of high boiling solvents is used and by suitable variation of the solvent mixture, it is possible to formulate lacquers between the very quick and rather slow drying classes.

Another important outlet for solvents is in the manufacture of artificial silk, where acetone is used. The shoe industry has become one of the big consumers of nitrocellulose solutions, in the form of lacquers for the finishing of leather, where flexibility is very important. Higher proportions of plasticisers are used for the finishing of leather than in the case of wood or metal. Nitrocellulose solutions are also used in the form of cements for the sticking of the soles of ladies' light footwear and for cementing the heels. Nitrocellulose is also used for the manufacture of the stiffeners for toe caps and heels and is applied in the form of a solution in acetone.

Related to the shoe industry is the leather industry which uses nitrocellulose solutions in these alcohol-derived solvents for the finishing of "split" leathers, which are afterwards calendered to give a "grain-like" effect. Artificial leather, too, is an outlet for solvents, as nitrocellulose solutions are built up on a paper or linen base and then suitably calendered to give the appearance of real leather.

Needs of the Plastics Industry

Small quantities of ethyl, butyl and amyl acetates are used as constituents of synthetic perfumes and essences, the pear drop smell of amyl acetate being particularly well known. This smell is also known as being characteristic of liquid nail varnishes. Nowadays, however, amyl acetate is usually substituted by one of the solvents with a rather less pronounced odour. Plasticisers, such as butyl stearate, are use in small quantities in the manufacture of lipsticks.

The plastics industry is becoming one of the large consumers of solvents, acetone being used in the manufacture and moulding of celluloid articles, in the manufacture of cellulose acetate and as a solvent for the welding of both these materials.

The printing and paper industry is also increasing its use of solvents. For some years now transparent paper of the cellophane type has been lacquered with nitrocellulose. Recent developments are the uses of low boiling, highly volatile solvents in the manufacture of special photogravure inks for use in high speed printing processes. The coating of paper with various finishes to give high gloss, water-proofness and durability, has also increased the consumption of solvents by the paper industry.

In this short survey some of the more important uses of solvents have been referred to. There are, however, many smaller outlets in which solvents are essential processing materials.

* From data supplied by Industrial Solvents, Ltd.

Letter to the Editor

The Late Mr. F. E. Hamer

SIR,—We have been sorry to read in your issue for May 21 the obituary of the late Mr. F. E. Hamer. He was well and favourably known on this side and we had frequent occasion to correspond with him, since for some time he contributed news concerning the progress of chemical industrial research and the chemical industry in Great Britain to the News Edition of *Industrial and Engineering Chemistry*.

The writer enjoyed very much association with him upon his last visit to the United States, during which he attended one of the meetings of the American Chemical Society. We occasionally extended greetings and shall miss him.—Yours faithfully,

H. E. HOWE.

Editor, "Industrial and Engineering Chemistry."

INSTITUTION OF CHEMICAL ENGINEERS EXAMINATION

THE Institution of Chemical Engineers announces that the following candidates were successful in the associate-membership examination for 1938: William Edwin Jolliffe, Arthur Glynn Jones, Pierre Etienne Rousseau. On the result of the examination, the William Macnab medal for 1938 has been awarded to Mr. Pierre Etienne Rousseau.

Solvents Serve Many Branches of Industry

Cyclohexanol and Related Products

HOWARDS AND SONS, LTD., are known throughout the solvent-using trade for the manufacture of cyclohexanol, cyclohexanone, and their homologues. Whilst these solvents originally formed the bulk of production, the last ten years have seen an ever-increasing market for their derivatives. Particularly is this so of the oxalate, phthalate, and stearate esters. Barkite and Barkite B, which are the methyl and dimethylcyclohexanol oxalates respectively, have found extensive application as plasticisers in the nitrocellulose lacquer trade, where their unique property of promoting gloss has been duly acknowledged and appreciated. Apart from their use in this field, they both have applications in the printing ink industry. A small percentage of either Barkite or Barkite B is sufficient to prevent skinning and oxidation on the rollers, of the more highly polymerised types of inks.

Transparent Resin-Coated Transfers

Cyclohexanol oxalate, differing from the liquid Barkite and Barkite B is a white crystalline solid, and like cyclohexanol phthalate, which it resembles in appearance, is used for plasticising synthetic resins and nitrocellulose. These plasticisers have an advantage over the liquid ones, in that a resin film plasticised with them has a higher and sharper melting point than if liquid plasticisers had been used for the purpose. This is a very important consideration in the manufacture of transparent resin-coated transfers. Of the other esters of methylcyclohexanol that have achieved considerable and important use as plasticisers, special mention must be made of Sextol phthalate and Sextol stearate (Sextol is the trade name for methylcyclohexanol). Sexton phthalate is one of the most interesting plasticisers introduced of recent years. Apart from nitrocellulose, its most important use is in the plasticisation of synthetic resins, especially of the urea-formaldehyde type, its low volatility making it an ideal plasticiser for all types of stoving finishes. Quite recently the lac research made extensive tests on all the plasticisers on the market for the most suitable plasticiser for shellac. It is interesting to note that Sextol phthalate was found to be the only one possessing a combination of most of the properties required for such a plasticiser.

Leather Dopes

Sextol stearate is used mainly in leather dopes. Formerly aliphatic stearates were used, but the fact that Sextol stearate has a lower setting point and greater gloss producing qualities, has caused it to be generally used in the leather lacquer manufacture. In chlorinated rubber lacquers, Sextol stearate proves itself an ideal plasticiser, imparting to the final film a remarkable resistance to water, acids and alkalis. Both the acetates of Sextol and cyclohexanol are good solvents for grease, and in this connection they are used for "spotting" grease stains on fabrics, and causing no "ringing."

Sextone (cyclohexanone) and Sextone B (methylcyclohexanone), having boiling ranges 150°-158° C. and 160°-175° C. respectively, and flash points 117° F. and 130° F., are widely used as solvents of the "medium boiler" type in nitrocellulose and synthetic resin lacquers, spirit varnishes and bitumen paints. They are particularly useful in lacquers on account of their high solvent powers for nitrocellulose and synthetic and natural resins and for imparting good flow and gloss, low viscosity, excellent adhesion (especially on leather) and very high blush resistance: another valuable property is their high dilution ratio to toluol, xylol and white spirit.

Sextol (methylcyclohexanol), boiling range 160°-180° C., flash point 156° F., is a powerful solvent for fats, oils, waxes, many dyes, a large number of synthetic and natural resins, shellac, etc. In addition it possesses excellent wetting-out and emulsion stabilising properties. Sextol, therefore, is a valuable ingredient in textile, laundry and dry-cleaning soaps, dye-baths, textile printing pastes, emulsifying agents, synthetic resin lacquers, paints, plastics, polishes, insecticides and disinfectants.

Diacetone alcohol, boiling range 160°-170° (92 per cent.), flash point 130° F., is a "high boiler" used in nitrocellulose and cellulose acetate lacquers and plastics, in spirit inks and in hydraulic brake fluids: it is particularly suitable for this last purpose on account of its low volatility, high flash-point and low freezing point, stability on heating and its complete absence of action on rubber and metals. Acetal solvent, boiling range 75°-85° C. (90 per cent.), is used in nitrocellulose and synthetic resin lacquers as a "low boiler," having an evaporation rate intermediate between those of ethyl and butyl acetates. In conjunction with alcohol soluble cotton it is useful for producing clear lacquer films with resins which usually give difficulty in blending: its low cutting power makes it particularly suitable for final coats.

Dipentene, boiling range 175°-185° C. (90 per cent.), flash point 130° F., is a cheap solvent of the terpene class widely used to prevent "skimming" in oil varnishes and synthetic resin finishes; it also improves flow and gloss. It is a useful solvent for chlorinated rubber. Being an excellent wax solvent and having a pleasanter odour than turpentine it is used in many wax polishes.

Recrystallising Fine Chemicals

Cyclohexane, boiling range 81°-84° C., is used for recrystallisation purposes in the fine chemical industry and for the extraction of essential oils; it is an ideal solvent for these purposes on account of its sharp boiling-point, pleasant odour and price. It is one of the most powerful solvents so far put on the market for paraffin wax and for crude rubber. Cyclohexylamine has only just been put on the market; it is a water soluble basic solvent, boiling point 135° C., having a high solvent power for many classes of dyes and having great possibilities in textile dyeing and printing and as an emulsifier. Technical ethers "730" and "720" are solvent ethers of narrow boiling range used for industrial and laboratory extraction purposes and for "spotting" stains.

Ethyl lactate, boiling range 145°-160° C. (95 per cent.), flash point 125° F., is a useful solvent in nitrocellulose, cellulose acetate and synthetic resin lacquers and plastics, in leather-cloth and in spirit varnishes; it shares with Sextone and Sextone B, the advantages of very good solvent properties and high dilution ratios and of imparting good flow, low viscosity and high brush resistance: it is a "high-boiler." Glycerol lactate, stable up to 200° C. without boiling, is a water-soluble solvent of very low volatility; it is an exceptionally powerful solvent for a wide range of dyes and is used in textile printing and in certain types of inks.

ALCOHOL FROM SISAL HEMP

SOME experience as to the possibility of producing alcohol from the sap of sisal hemp plants have been carried out in French West Africa. The plant is grown and cut in the usual manner for the preparation of fibres; immediately after cutting, however, it is pressed to remove the sap. An ordinary grape press is used for the purpose, and permits the extraction of about 70 per cent. of the sap. This sap is run into vats in which it is fermented with a ferment found on the root of the sisal hemp plant itself and known as *Amylomyous Renouxii*. Ordinary ferments cannot be used as the sap will tend to decompose. After fermentation, the sap is distilled in the ordinary manner. The production of pure alcohol is about 55 gallons per ton of sisal hemp fibre.

Industrial Lacquer Solvents

By
R. M. ESDAILE
Commercial Solvents (Great Britain) Ltd.

As with synthetic resins, there was a time when new solvents made their appearance at frequent intervals. For each new solvent the claim was made that the newcomer was the perfect lacquer solvent, suitable for indiscriminate use with acetate or nitrate, and at the same time possessing an extraordinary tolerance for dilution with aliphatics or aromatics alike.

As soon as the use of synthetic resins in lacquer formulation became standard practice, these new solvents had another lease of life as their qualities were claimed to render them suitable for both natural and synthetic resins. After spending a considerable amount of time and trouble examining this claim, the work's chemist came to the conclusion that there would always be two sides to a fence and that it was not possible—perhaps one should say " so far "—to satisfy both maximum solvent power for nitrocellulose with maximum solvent power for natural and synthetic resins, and at the same time to possess the maximum tolerance for any diluent.

Simplifying Solvent Formulæ

These variable factors will always be with us, and formulators have therefore to act accordingly. In spite of this, however, simplicity has taken the place of complexity in solvent formulation, and the majority of lacquer formulæ are based on ethyl and butyl alcohol, their esters and acetone, the particular solvents upon which Commercial Solvents (Great Britain), Ltd., concentrate.

The simplification of solvent formulæ has been made necessary not only from the fact that such formulæ have been proved to be the most economical, both from the technical and from the purchasing point of view, but also from the fact that recovery processes can be most efficiently operated under these conditions.

Simplification of solvent mixtures demands that the solvents used should be of consistent quality. The combination of chemical and engineering skill in the modern solvent factory has made it possible to guarantee to the consuming trades raw materials of unsurpassed quality. The commercial article of uniform specification is no longer a rarity, and it is now possible to have all formulæ based on products with a quality of this order. Impurities in the past have been condoned on the argument that they affected little, if at all, the solvent power of the resultant mixtures—the loss of excess tolerance, it was claimed, being within the margin of safety. The modern technologist, however, prefers not to work with unknowns, but to be in the position to add his own " impurities," as desired.

Factors Governing Choice

There are several factors, governing the choice of the most satisfactory solvents in a solvent mixture, which have remained unchanged since cellulose lacquers were first produced, such as viscosity of solution, cost, recovery efficiency, consistent quality, etc. Solvent power, which is related to the viscosity and the film-forming capacity of lacquers, depends entirely on the proper proportion of solvents employed.

The range of esters, alcohols and ketones manufactured by Commercial Solvents includes solvents for nitrocellulose, cellulose acetate, ethylcellulose, natural resins and synthetic resins. The ester solvents, due to their high solvent power, high tolerance to dilution with aromatic or aliphatic diluents, and their resistance to moisture effects, remain the principal solvents for nitrocellulose. Cellulose acetate solvents are represented in this range by acetone and ethyl lactate. In addition, the alcohols when mixed with other materials also occur in solvent mixtures for cellulose acetate. The synthetics rely principally upon the aromatic hydrocarbons for solution, coupled with smaller quantities of esters and alcohols. When used with cellulose in combination lacquers, however, their well-known effect of raising the viscosity and producing poor flow in lacquers, necessitates substantial changes in the formulation of the solvent mixture, and the inclusion of suitable proportions of alcohols. When used in conjunction with nitrocellulose, the disadvantages of the alcohols has to be taken care of by increasing the proportion of medium-boiling solvents, such as butyl acetate.

The trend in formulation of nitrocellulose finishes has been governed by the competition with straight synthetic finishes and the demand on the part of users for material of equivalent film-forming capacity with, at the same time, the well-known advantages of nitrocellulose as a finishing material. Of particular interest in this respect is the work being done on the preparation and use of high-solids lacquers, in order to meet the complaint that cellulose lacquers have poor film-forming capacity, and are of poor flow, compared with synthetic finishes, at the same time retaining the obvious advantages of the nitrocellulose film. The increase in the solid content of nitrocellulose lacquers is dependent upon several factors, which taken together can show at least 100 per cent. increase in the film-forming capacity of a normal lacquer. The measure of greatest importance in bringing this about is the elimination of excessive dilution, especially when connected with the use of alkyd resins. It has been shown that a reduction of 15-20 per cent. in the amount of diluent will allow by the use of synthetic resins an increase in solid content of some 30-40 per cent. A further increase in the solids applied can be obtained by operating at higher viscosities which can be permitted in lacquers containing larger than average proportions of butyl compounds. The problematical decrease in drying time is not serious when it is realised that normal lacquer formulation necessitates the inclusion of this material, which would therefore control the drying time in both cases.

Lacquer Emulsions

Experiments have also been made with the application of lacquers at elevated temperatures, and here again it has been found possible to apply a greater proportion of solids if the necessary alteration in the boiling range of the solvents—which means the use of more medium boilers—is carried out.

A completely new method of obtaining greater solid-forming lacquers is due to the experiments with lacquer emulsions. In this case highly viscous nitrocellulose solution became standard practice, these new solvents had by the continuous water phase. Water-immiscible solvents, such as butyl acetate, are here again a necessity, as water-miscible solvents, such as the ketones, would naturally break down any emulsion.

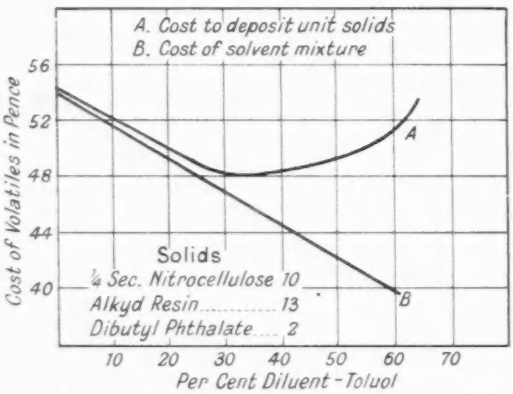
Competition in nitrocellulose finishes has been so keen that the cost of the final film has often been neglected in favour of the initial cost of the lacquer. It is unnecessary to draw the attention of expert formulators to the evils of excessive dilution on the plea of cheapness, although the harm such a practice can do cannot be too often stressed, when the technologist is being continually harassed to formulate something with a low first cost. That the finishing cost should be sacrificed to expediency in quoting a low price per gallon can only be harmful to the finishing trades for the simple reason that the finisher pays for solids which

stay on his work, and not for diluents which overwork his ventilating fans.

The use of synthetic resins, particularly of the alkyd type, has made it more than ever necessary to guard against excessive dilution, and to use instead ample proportions of medium-boiling solvents. The chart below illustrates the economics of this important factor.

The use of both ethyl and butyl alcohols as diluents, which are activated by the normal solvent proportions of a lacquer solution, has become general in view of the necessity of high solid content at spraying viscosities. Alcohols are well known for their ability to reduce relative viscosity, and ethyl alcohol has the advantage of cheapness. Such a practice is permissible when using ample proportions of medium-boiling ester solvents such as butyl acetate.

The increased use of petroleum diluents—especially encouraged by the fluctuating market in aromatic hydrocarbons—is also a feature of modern lacquer formulation. In view of the fact that petroleum hydrocarbons cannot be used to the extent or in the proportion to solvents as is the case with aromatic hydrocarbons, it is necessary to increase



The effect of diluent proportion on the cost of solvents required to apply 2.25 lbs. of a nitrocellulose-alkyd resin mixture at constant viscosity.

the solvent proportion in lacquers of this type. This may at first sight appear to negative any advantage of the one over the other, but, depending upon the relative prices, such a practice is advisable if sufficient ester solvents are used, on account of their greater tolerance for dilution with aliphatic hydrocarbons.

It is impossible to give the range of products which depend for their production on solvents, such as manufactured by Commercial Solvents, as all types of coatings, including many kinds of solid-forming materials, depend upon these solvents for their production, even if one omitted to name those industries which use these materials as intermediates. Attention, however, may be drawn here to one new outlet for nitrocellulose lacquers in the field of paper finishing. This type of finish is finding favour owing to the numerous advantages of a nitrocellulose coating over one made with ordinary spirit varnish. A paper coated with lacquer has many advantages—for example, it is impervious to moisture; it will not chip, crack or peel; it is proof against finger-prints, oils and grease; and will withstand moderate chemical action.

The extra cost of such a coating is at first sight a drawback, but it has been proved upon several occasions to be an economy in the long run. The preservation and protection of the appearance conferred by a lacquer coating gives a life to the article coated which repays many times over its initial cost.

The formulator to-day has a variety of solid film-forming materials from which to choose, and his choice of solvents is naturally affected by the requirements of the solids and the resultant film. Of the products manufactured by Commercial Solvents, butyl acetate remains the standard medium-boiler, ethyl acetate the standard low-boiler, both for nitrocellulose. Acetone is the standard low-boiler for cellulose acetate, while ethyl lactate is a high-boiler for the same material. The solution of synthetics and hydrocarbons is assisted both by the use of ethyl and butyl alcohols and their esters. The economy and homogising effect of the alcohols in cellulose lacquers is also made use of by the expert formulator. Recovery processes depend upon the simple solvent formulæ of which the above are standard constituents.

Chemical Matters in Parliament

Power from Coal

IN the House of Commons on Wednesday, Col. Sandeman Allen moved an amendment to Clause 2 to reduce the period of the preference for home-produced oils from 12 years to six years. Major Owen said that the Falmouth Committee report proved conclusively that it was impossible to produce oil from coal on a commercial basis. Mr. James Griffiths complained that the oil interests had done all in their power to try to prevent the development of the extraction of oil from coal.

In reply, Captain Crookshank said that the amendment would not meet the view expressed in the Falmouth report, and took them nowhere. In justification of the clause he might say that the country was still without sufficient experience of the different processes to know whether within a reasonable time these would be economically possible. It was essential that opportunity should be afforded to scientists to proceed with their researches and to make such modifications of plant as experience dictated.

The amendment was withdrawn and the clause agreed to.

Power Alcohol

On Clause 3 Mr. H. Williams moved an amendment which sought to halve the proposed Excise duty on power alcohol. His purpose, he explained, was to encourage the production of this spirit in this country. Mr. Lewis Jones pointed out that in 1931-2 18,331 gallons of power alcohol were produced in this country, while the estimated productions for 1938-39 was 9,332,000 gallons. In 1936-37 only 7.9 per cent. of the raw materials used in the manufacture of power alcohol was home-grown.

Sir John Simon said he had looked into this matter very carefully and had come to the conclusion that the clause should not be altered. Petrol had been taxed in this country since 1928. At that time the production of power alcohol was infinitesimal. Last year it was approximately 6,500,000 gallons. If 15 per cent. of existing petrol consumption was replaced by power alcohol it meant the replacement of 200,000,000 gallons, which taxed at 9d. a gallon was £7,500,000. If this were allowed to go on it would not only mean that the country would lose revenue but a competitive business would carry on without taxation.

The amendment was negatived.

COMING OF AGE OF THE T.I.G.B.

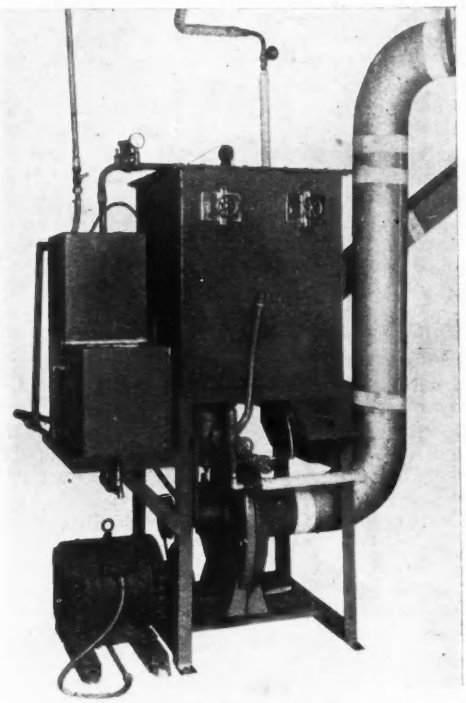
THE Technological Institute of Great Britain established during the war with the primary object of meeting the urgent demand, existing at that time, for technically-trained engineers completes its twenty-first year of existence this year. Starting in a small way the Institute now provides courses of training, specially planned and arranged to suit every man in every grade and branch of engineering. Owing to demand, a special department was opened for instruction in chemical and fuel technology. The courses available in this department include chemical engineering processes, chemical plant construction, chemical works design and construction, and chemical works organisation and management. It is worthy testimony that at the last sitting one of the T.I.G.B.'s students obtained first place and the MacNab prize in the examination of the Institution of Chemical Engineers.

Solvent Recovery Plants

Co-operation Between Active Carbon Maker and Plant Manufacturer

By J. C. LIDDLE

THE recovery of solvents by means of activated carbon is now so well established that it is difficult to believe that only ten years ago it was regarded by the majority of solvent users with scepticism. As the technique of this process was then little known, active carbon manufacturers were compelled to design and supply plants to develop the sale of their carbon. To-day, this is no longer necessary, and there is no reason why any firm with suitable engineering capabilities should not produce highly efficient solvent recovery plants, always assuming co-operation with the manufacturer of active carbon, who can supply the necessary data concerning his product. On these lines, the Brimsdown Chemical Works, Ltd., who specialise in the manufacture of several totally different kinds of activated carbon, work in conjunction with specialised engineering firms in each field of their activities.



A unit developed by Brimsdown Chemical Works, Ltd., for removing traces of valuable liquids, etc., from air.

One of the most active fields of recent developments is that of small units, such as can be used in connection with dry-cleaning plants installed in shop windows. The accompanying diagram shows the lay-out of the Eclipse solvent recovery plant, produced by W. M. Still and Sons, Ltd., and marketed by James Armstrong and Co. It is claimed that this little machine has a remarkably low steam consumption of approximately 0.7 lb. of steam per 1 lb. of solvent. In the case of the junior model, the steam is obtained from a 1 h.p. coke-fired boiler. This small consumption is important, since the majority of users of this type of plant are seriously restricted by their boiler capacity. The great simplicity of the plant is illustrated by the photograph.

In the field of larger solvent recovery units, a plant manufactured by Geo. Scott and Co., which is used for recovering a mixture of benzene and acetone, is of interest. The back pressure of the 4 ft. deep beds of Brimsdown carbon proved to be only 3 ft. 4 in. W.G., the plant working under a partial pressure. The suction ducting is so arranged that it ventilates one part of the building and the concentration of solvent vapour increases, as rich vapours are picked up on the way to the recovery plant.

There is no practical reason why any good quality of active carbon should not be mixed with, or replaced by, another make of similar quality. The size of the grain naturally affects the resistance to air flow, and the smaller grains have a higher volume activity than large grains, but it is found

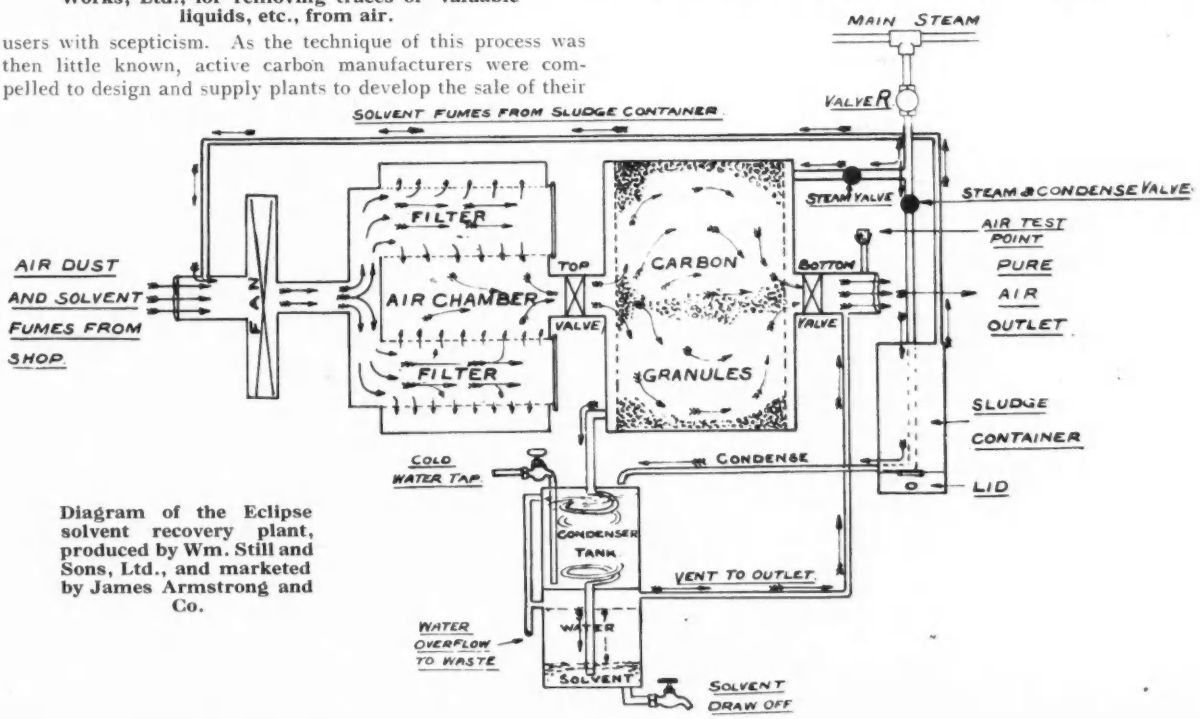


Diagram of the Eclipse solvent recovery plant, produced by Wm. Still and Sons, Ltd., and marketed by James Armstrong and Co.

that within reasonable limits the shape of the grains is not of great importance. Under similar conditions, the weight of solvent absorbed in each cycle of operation, and the timing of the cycle, is determined by the working range of a fixed volume of carbon. To compare the merits of two carbons it is, therefore, advisable to carry out tests on a volume activity basis, in preference to weight percentage capacity, which may be misleading in favour of a lower density carbon. Generally speaking, there are so many varying factors to be taken into consideration when designing a solvent recovery plant, that a comparatively small difference in the working range of the carbon is not of vital significance. Owners of plants have, therefore, a much wider choice of activated carbon than is generally appreciated.

A new development closely allied to solvent recovery is the application of active carbon to air filter units for removal of traces of volatile liquids, which it is not necessary to recover, dust and smoke, from air. Great activity is being shown in this field in connection with air raid shelters. Brimsdown Chemical Works have developed a special unit for this purpose. It is so arranged as to give good distribution of the air through the carbon. It offers a large area in proportion to its size and in consequence the resistance to air flow is small. The carbon is housed in a detachable unit which can be removed and replaced in a remarkably short space of time.

Pumping Solvents

A Pump which Avoids Trouble

THE pumping of volatile solvents is known to be a difficult problem. Many types of pumps which give admirable service on ordinary applications fail completely, or are a constant source of trouble, when installed for handling solvents.

To be successful for this purpose, a pump should run at a slow speed, and be of the rotary type, in order to avoid the necessity for valves. The liquid should flow through in an even stream without violent changes of direction or velocity, thus avoiding local changes of pressure which will often produce vaporisation and gas locks. Furthermore, the pump should be able to run without excessive wear when lubricated on its working parts with nothing but the solvent which is being pumped.

The Douglas concentric rotary pump has been designed to meet these requirements, and has a highly successful record for handling solvents of all types, over a number of years. Solvents have to be pumped to serve a number of purposes; apart from those used on industrial solvent extraction plants, can be made of the handling of benzine, white spirit, and trichlorethylene in the dry-cleaning of clothes, ingredients, and the handling of petrol from underground tanks to metering systems.

The Douglas concentric rotary pump is positive in action, and the accompanying illustration gives details of the principle upon which it works. The suction is marked F; delivery, G. The pins C D E rotate in the direction shown by arrow, and in their progress rotate the drum A, which latter acts as a seal preventing the liquid passing from the delivery to the suction side. The crescent B is stationary. Under working conditions the black spaces between the plungers C E and C D would be filled with fluid—between C and E is the fluid sucked in through inlet F, whilst the fluid between C and D is about to be forced out through delivery G.

HYDROGENATION MOTOR FUELS ARE BEING MANUFACTURED at Perstrop from wood, wood shavings, wood charcoal and wood tar, by the A.B. Skanska Aettiksfabriken.

Boots Pure Drug Co., Ltd.

Progress of Fine Chemical Department

THE 50th annual ordinary general meeting of Boots Pure Drug Co., Ltd., was held at Nottingham on June 16, Lord Trent, chairman of directors, presiding.

According to the profit and loss account, trading profit, after providing for contributions to staff pensions funds, management remuneration, and income-tax, and also after deducting £36,000 for National Defence Contribution, amounted to £940,332, against £966,116—a decrease of £25,784. Repairs and renewals showed an increase of £13,021. Depreciation showed a decrease of £949. During the year 1937-38, £15,000 has been allocated to cover depreciation of plant, in addition to the £81,349 debited to depreciation in the profit and loss account, so that the total amount used for this purpose during the year is £96,349. The net balance, after charging all these items amounted to £762,625, a decrease of £37,273.

After payment of all preference and preferred ordinary dividends, and of four quarterly dividends of 6 per cent., less tax, on ordinary shares, the company had a balance of £281,875, which, together with the balance brought forward, amounts to £598,862, as compared with £617,238 last year. The payment of a bonus of 3d. per share, free of income-tax, on the ordinary shares, absorbing £80,000, was recommended.

Additional to the new factory at Beeston for the manufacture of potassium permanganate, the company has now added a second large process building for the manufacture of bismuth salts, chloroform and aspirin, and the space at their Island Street factory rendered vacant by the transfer, has been utilised for growing requirements in the manufacture of biological products, such as insulin, protamine insulin (with zinc) suspension, and liver extract. A further important development in the fine chemical department during the past year is the manufacture of sulphanilamide, the drug which has recently been discovered to have such important application in streptococcal infections, such as puerperal fever.

Trade in Egypt and India

The wholesale and export department has maintained its progress during the past year. The wholesale connection at home has continued to expand and the export figures show a material increase. The action of the company in increasing the number of representatives in India reported last year, has been justified by a steadily increasing sale of our products in India, Burma, Malaya and Siam. Following a visit paid by the head of the wholesale and export department to Egypt, Palestine, Syria and the Sudan, agencies were arranged and extended in those markets, with results that up to date have been most encouraging. Trade in Canada and South Africa has shown healthy development. With regard to New Zealand, the directors are quite satisfied with the steady progress which our two pioneer branches in Auckland and Wellington have made in all sections.

In the veterinary section the extensive range of products are increasingly in demand and notable additions are being made as the result of constant research and experiments with the collaboration of some of the leading veterinary practitioners. Among such new products already on the market, mention may be made of calcium borogluconate solution for the prevention and treatment of milk fever.

The company has continued to conduct their medical and scientific research work in close collaboration with distinguished research workers in the universities, hospitals and other institutions. Their advice has been invaluable, particularly in connection with the range of special medical products, which has been extended during the past year. At the same time the company makes their own contribution to the medical research work of the nation by contributing or loaning chemicals or apparatus to other research laboratories and by providing consultants with research workers.

Institution of Civil Engineers

Exhibits of Scientific Interest shown at Conversazione

AN exhibition of engineering models and scientific apparatus was staged at the conversazione held by the Institution of Civil Engineers on June 15 at Great George Street, Westminster. Although the exhibits were, of course, primarily of interest to the engineer, there were several displays of a wider scientific interest.

Sir Robert A. Hadfield, F.R.S., showed a colour-temperature optical pyrometer in actual operation. In the instrument exhibited, known as the Bioptix, the colour of the heated object is estimated from the relative proportions it contains of red and green radiations. One of the many exhibits arranged by the National Physical Laboratory was concerned with the deformation and fracture of metals. It illustrated results obtained in the engineering department of the laboratory by a mode of attack employing precise methods of X-ray diffraction. The X-ray photographs shown had been obtained from specimens of normalised and cold-worked mild steel at different stages in their history as the specimens had been subjected to systematic static tests and cyclic stresses of various types.

A Donaldson trichromatic colorimeter was exhibited by F. W. Twyman, F.R.S. This is a fully standardised trichromatic colorimeter by means of which any colour can be measured and specified in terms of the C.I.E. standards. A water-softening plant giving complete de-aeration and zero hardness was displayed by W. H. S. Aplin. The process comprised three stages: The thermic stage, the alkaline pre-softening stage, and the trisodium phosphate stage. An exhibition of special kinds of timber and derivatives arranged by E. Kilburn Scott included the following items: Highly compressed beech in thin layers cemented together by Tego film of synthetic resin (Wood Airscrew Co., Ltd.); "Permali" wood insulators consisting of beech impregnated with synthetic resin and highly compressed (New Insulation Co., Ltd.); wood treated with "Faspos" compound to make fireproof (Imperial Chemical Industries, Ltd.); wood-flour; ground-wood pulp, and sulphate pulp and sulphite pulp; viscose; artificial silk, artificial wool, dress fabrics and cloth by Snia Viscosa; British Celanese, Ltd., and Gruppo CISA Viscosa; and sweetmeats made from wood sugar, by the process of Dr. Bergius. Finally, the exhibition contained models of the Team Valley Trading Estate, the Treforest Trading Estate, and the Scottish Industrial Estate, exhibited by the Commissioners for the Special Areas.

Production of Iron Phosphide

Compound Corresponding to the Formula FeP

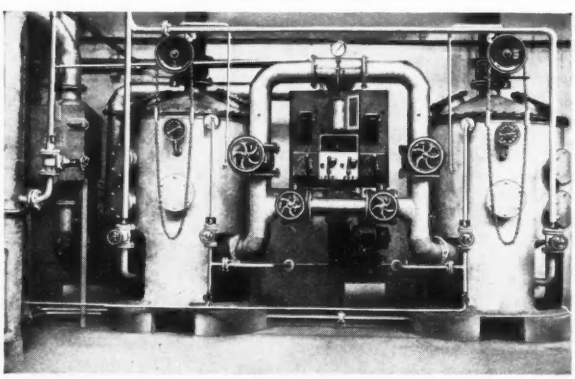
J. L. ANDRIEUX and Marcel Chene report to the Academy of Sciences (*Comptes Rend.*, May 23) the production, by electrolysis, of an iron phosphide corresponding to the formula FeP. Metaphosphoric acid 16 parts, ferrioxide 1 part, and sodium fluorides 4 parts, was electrolysed with a current of 5 amps. at a potential of 5 volts for 1½ hours, the temperature reaching 850° C. From the resultant product 5 grams of FeP were obtained, in steely gray, slightly magnetic crystals with a density of 6 and a high chemical resistance. On analysis these crystals showed a composition of P = 35.2 per cent., Fe = 64.5 per cent., whereas the theoretical composition of FeP should be P = 35.71 per cent., Fe = 64.29 per cent. The crystals keep their brightness even when heated in air to 100° C., but are slowly attacked by alkalis, especially by the alkaline persulphates. This compound does not seem to be the same as the powdery blue or black substance previously described by various authors as being FeP.

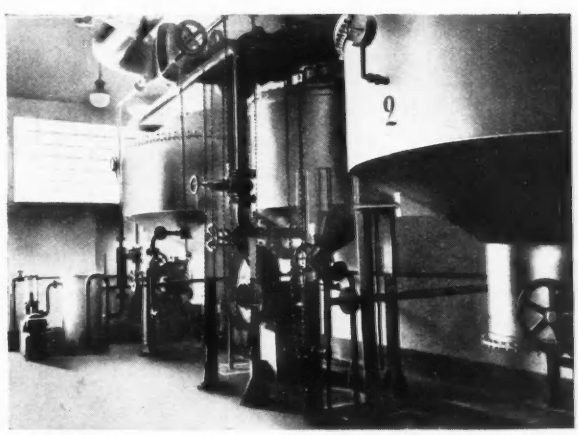
Quick-Drying Stamp-Pad Ink

New Use for "Butyl Carbitol"

THE development of a satisfactory formula for a quick-drying stamp-pad ink is described by Waters (*Bureau of Standards Journal of Research*, 1938, *20*, 543-547).

Ordinary stamp-pad inks consist generally of a mixture of glycerol and water with a small amount of the appropriate dye. The glycerol prevents evaporation of the composition from the pad, and drying on paper is by absorption mainly, which is slow. To increase the rapidity of drying by increasing the rate of absorption, alcohol or ethyl acetate is often added, but the range of compositions in which rapid absorption will occur is so small, that evaporation of a small amount of the volatile liquid renders the ink again a slow-drying one. It has been found that "butyl carbitol," which is the mono-butyl ether of diethylene glycol, is as efficient as alcohol in promoting rapid absorption by paper of the ink to which it is added, and since its boiling point is 222° C., it is almost non-volatile. The best composition was found to be 40 per cent. glycerol, 40 per cent. water, 20 per cent butyl carbitol, by volume. A pad impregnated with such a mixture can be left open for weeks without losing its quick-drying properties.





Two examples of recent work of Carbonisation et Charbons Actifs, owners of the "Acticarbone" process of solvent recovery, whose representatives here are Price, Stutfield & Co., Ltd. Above: A small compact two absorber plant showing its simple control. Right: A two absorber plant on the recovery of benzine showing absorbers, controls, condenser and decanter for the recovered solvent.

The International Congress of Chemistry at Rome

Thirty-Three Nations Represented

THE International Congress of Chemistry was inaugurated in Rome on May 15, and closed towards the end of the month, various reports and papers being submitted by 2,800 delegates representing 33 nations. The opening meeting was attended by the King of Italy and the Italian Minister of the Exchanges and Currencies.

Professor Nicola Paravano, chairman of the Congress, pointed out that the Rome meeting, taking place four years after the Madrid meeting, represents by itself a further achievement of chemistry, since in the course of the past four years important progress has been made in the chemical researches in connection with the study of the atom, and in connection with synthesis. He referred to the output of synthetic sexual hormones, and to the various latest processes connected with the exploitation of the crude oil distillation gases, hydrogenation of coals, lignites, and bitumen, etc. He also discussed the question of the synthetic rubber which, he said, is better than the raw rubber from the point of view of its resistance to work, and to solvents. Professor Paravano concluded his speech by referring to the achievements of chemistry in the textile industries and especially to the output of wool from milk, and in certain circumstances also from the ordinary "viscose" submitted to special chemical treatment.

Professor Hinshelwood (Great Britain), speaking in Italian, dealt with the contribution of physical chemistry to the scientific thought, and described especially the relations existing between scientific theories and practical applications. Professor Swietoslawski (Poland), Minister for Public Education in Poland, outlined the necessity that it is extremely important for the independence of the countries to develop the applications of chemistry, and described the steps which should be taken to favour chemical researches and to encourage the youth to devote itself to chemical studies applied to industries. Professor Bergius, Germany, Nobel prizewinner, and well known for his important process for the output of synthetic gasoline, spoke about the process to obtain saccharine from lumber, announcing that such process is at the eve of its industralisation.

Fuels for Internal Combustion Engines

H. E. Giordani (Italy) submitted a report on the possibilities of exploitation of thermic energy, which, he said, is a problem of vital importance for the countries who do not have much fuel supplies. He dealt especially with the problems of a better exploitation of fuels in the internal combustion engines, and has spoken of the anti-detonant properties of isoottan and of the employment of lead tetraethyl to reduce the detonant properties of ordinary spirit in order to obtain a regular explosion in the motors with a high degree of compression as those employed in aviation. He concluded his report by dealing with the steels which have noteworthy properties of resistance at high temperature in relation to their employment for the construction of thermic engines announcing the possibility to replace mercury with phenyl oxide in the mercury vapour boilers.

Professor M. P. Ruggli submitted his report on the influence of chemistry on the building materials, illustrating the advantages of the steel constructions in respect to the protection against rust and corrosion, and of the new chemical treatment of wall coverings, and of textiles employed in furnishing, especially with reference to the progress in the dying.

Professor Ettore Viviani (Italy), connected with the Cisa Viscosa group of Rome controlling important artificial fibres factories, submitted a report dealing with the influence of chemistry on clothing, and made a comparison between the chemical properties of raw fibres, and the chemical properties of artificial fibres outlining the achievements which have already been obtained, and the achievements to which chemistry must tend especially in connection with the softness and heating qualities. He said that in order to obtain good textiles it is necessary to study first the properties of the raw and of the artificial fibres to be mixed.

Professor Butendadt, of the Kaiser Wilhelm Biological Institute, Berlin, dealt with the influence of chemistry on sexual problems insisting upon the different physiological activity of the hormones in respect to the variation of their structure and on their nature of exciters, while Professor Hans von Euler, Nobel prizewinner for chemistry, dealt with the importance of the vitamins and hormones in food and in human organs, insisting upon the fact that feeding tendencies of the populations should be directed towards the employment of foods containing special vitamins.

The organisers of the Congress arranged for the various delegates to visit some of the leading chemical factories in Italy, including the aluminium plant of the Montecatini concern at Bolzano (which supplies the Bayer system with one-third of the Italian output of aluminium), the synthetic wool plant of the Snia Viscosa at Cesano Maderno, the Acna inorganic chemical product factories at Milano, Cengio and San Giuseppe Cairo (Savona), and the various chemical plants at Porto Marghera (Venice), including also the lead and zinc works adjacent to the Venetian lagoons.

Indian Chemical Industry

Heavy Chemical Manufacture Well Established

ALTHOUGH the chemical industry was established in India a long time ago, the existing plants are small and development along modern lines was started only recently, according to the American Trade Commissioner at Calcutta. Domestic producers are able to supply only a small portion of the local requirements, but self-sufficiency in chemicals—particularly the heavy group—is the ultimate goal of the industry, and considerable progress toward that end has been made the last few months.

The Alkali and Chemical Corporation of India, Ltd., capitalised at $19,000,000, has been formed as a subsidiary of Imperial Chemical Industries (India), Ltd., to produce soda ash, caustic soda and chlorine. Khewra, in the Jhelum district of the Punjab, has been chosen for the site for the soda ash plant. The factory for the manufacture of caustic soda and chlorine will be erected in or near Calcutta. Tata Sons, Ltd., of Bombay, contemplates the manufacture of caustic soda and soda ash in a plant to be erected at Port Okha, Baroda. The Mettur Chemical and Industrial Corporation, Mettur, was formed to manufacture caustic soda, liquid chlorine, bleaching powder, hydrogen, and other chemicals. In the initial stages, the company will confine itself to the manufacture of 5 tons of caustic soda and 4½ tons of chlorine daily. The Mettur area was selected as the location for the plant because of the availability of electric power from the Mettur Dam at low cost.

Toward the end of 1937, the Mysore Chemical and Fertilisers, Ltd., Mysore, was established, and it plans to manufacture 25 tons of hydrochloric acid and 20 tons of ammonium sulphate daily. The chemical plant constructed by the Jubbulpore Chemical Co., Ltd., Jubbulpore, near the Sleemanabad Road railway station about 17 miles from Katni, was completed early in 1938, according to reports. This new factory is equipped to produce 3 tons of sulphuric acid daily, and 600 tons of copper sulphate and 750 tons of aluminium sulphate annually, as well as other heavy chemicals. The Mysore Chemical Manufactures, Ltd., Bangalore City, was established early in 1938 to manufacture industrial and fine chemicals.

Centenary of George Kent, Ltd.

Sir Walter Kent Describes Company's Growth

THIS month marks the centenary of George Kent, Ltd., the well-known manufacturers of measuring and controlling instruments, of Luton, Bedfordshire, and the occasion is unique in that father and son, namely, Mr. George Kent, the founder, and the present chairman, Sir Walter Kent, have between them controlled the business for the whole period of 100 years.

THE CHEMICAL AGE was represented in the party of members of the technical press who visited Luton on June 17 to view the excellently organised Kent works and to partake of luncheon at the invitation of the directors. Sir Walter Kent—looking remarkably well and youthful for all his eighty years—presided at the luncheon which followed the tour of the works, and which was held at the George Hotel. He was supported by the following members of the board of directors, Colonel G. H. Kent, Mr. Leslie H. Kent, Commander P. W. Kent, Mr. D. T. Anstruther, Mr. R. E. Handford, Mr. W. G. Ardley and Mr. H. Leese.

Sir Walter Kent made an excellent after-luncheon speech, in the course of which he gave a brief outline of the history of the firm. Speaking with justifiable pride of the early struggles of his father, George Kent, who founded the firm, Sir Walter said: "Fifty years after his founding the business—and it is of interest that this great departure in the nature of the firm's work should have commenced at the half-way house in its age—water measurement work was introduced in the shape of the Uniform water meter, and from this one small engineering shoot grew a great tree, which, so far as the firm is concerned, must be compared to the banyan tree, spreading over a wide field of commercial enterprise and dropping its roots here and there into many varied industrial processes. In doing this, science was combined with art in the employment of the great motive forces of modern life—mechanics, hydraulics, electricity, pneumatics, and chemistry.

"This development of the firm's work was founded upon the researches of Giovanni Battista Venturi, which were closely allied to the work of Bernouilli. Venturi in 1797 established after a long and meticulous series of experiments and observations the laws pertaining to the flow of water in converging and diverging pipes: these laws were put to practical use by Clemens Herschel, the great American hydraulician, who, in 1887, constructed the first meter employing this principle, which, with a rare and commendable modesty, he named "The Venturi." The knowledge of the efficiency and success of this new method of measuring water in bulk was imparted to the engineering world in a paper read before the American Society of Civil Engineers in 1888, and through the perspicacity of George D. Robertson, the manager of the water meter branch of our business, who happened to be in the United States shortly afterwards. We succeeded in obtaining the rights for the whole world to make and sell this meter, with the exception of the Continent of North America.

Sir Walter Kent.

"Closely allied with the Venturi and arising from the principle of differential measurement, the use of the orifice in many special instances has developed and has been made an integral part of our work. In this we were very fortunate in having on our staff the late Mr. John Lawrence Hodgson, who was regarded as a high authority upon this principle which now figures so widely in applied engineering science.

"It is the firm's claim to measure and control the flow of all fluids both liquid and gaseous, and the modern practice of automatically controlling industrial processes has led to a further development of our activities. This may be said to be the age of automatic control; whether it be steam-raising, sugar purification, paper-making, water and sewage purification, automatic control is rapidly taking the place of adjustment by hand. Perhaps some super-physiologist could draw a parallel between human and mechanical control, but the vast amplification of power brought into operation by the minute effort of the automatic observer or detector almost overtops one's arithmetical conception."

Proposing a vote of thanks to Sir Walter Kent and his colleagues for their hospitality, Mr. John Benn, a director of THE CHEMICAL AGE, said that for a great business to have two chairmen only in a century was surely a unique occurrence in the history of British industry. Certainly he had been unable to find another case of a father and son covering such a long period. Mr. George Kent, the founder of the firm, had been apprenticed a hundred years ago to W. Barrett and Son, Ltd., of Piccadilly, a firm still in existence, the present head of which was a man of 77, who attended his office every day.

"I am told," Mr. Benn continued, "that one of Sir Walter Kent's gifts is an ability to throw off his work when he is away from it. At the age of 80 he still walks two miles across Harpenden Common on his way to the works in the morning, and is keenly interested in many activities besides business." This appeared to be characteristic of his colleagues also. Colonel Kent had had a distinguished military career, Commander Kent had served in the Navy, and another director, Mr. Leslie Kent, was both an A.M.I.C.E. and an exhibitor at the Royal Academy. Mr. Benn added, amid laughter, that the assistant managing director, Mr. W. G. Ardley, could not be persuaded to take up any hobbies, but the staff and workpeople were to have an extra day's holiday during the centenary celebrations.

The fourth generation was represented in the business by Mr. Wilfred Kent and Mr. Rodney Kent, which augured well for its continuity and future success.

A silver coffee set being presented to Sir Walter Kent by the staff and employees on June 16.

British Overseas Chemical Trade in May

ACCORDING to the Board of Trade returns for the month ended May 31, 1938, imports of chemicals, drugs, dyes and colours were valued at £926,410 as compared with £1,038,810 for May, 1937, a decrease of £112,400. Exports were valued at £1,891,267 as compared with £2,135,035, a decrease of £243,768. Re-exports were valued at £36,591.

Imports

	Quantities. May 31,		Values. May 31,	
	1937.	1938.	1937.	1938.
Acids—				
Acetic .. .. cwt.	15,422	8,251	17,172	9,948
Boric (boracic) .. ,,	5,301	2,925	5,277	3,091
Citric .. .. ,,	2,102	2,770	8,295	11,273
Tartaric .. ,,	3,543	2,842	14,688	12,709
All other sorts .. value	—	—	7,739	6,781
Borax .. .. cwt.	35,508	24,037	19,549	13,483
Calcium carbide .. ,,	96,463	134,465	49,966	63,346
Fertilisers, manufactured—				
Superphosphate of lime tons	2,436	396	5,983	988
All other descriptions ,,	610	679	2,696	4,154
Potassium compounds—				
Caustic and lyes cwt.	14,263	5,996	14,586	6,856
Chloride (muriate) ,,	20,600	24,000	7,630	7,807
Kainite and other potassium fertiliser salts cwt.	26,140	27,479	3,716	3,440
Nitrate (saltpetre) ,,	2,435	3,112	2,273	2,871
Sulphate .. ,,	15,060	13,820	6,787	6,547
All other compounds ,,	8,158	9,801	11,194	13,636
Sodium compounds—				
Carbonate, including soda crystals, soda ash and bicarbonate cwt.	262	809	111	649
Chromate and bichromate .. .. cwt.	1,070	934	1,217	1,150
Cyanide .. ,,	3,227	4,106	7,148	9,449
Nitrate .. .. ,,	62,260	30,381	13,572	7,481
All other compounds ,,	21,132	16,858	16,794	17,263
Other chemical manufactures .. .. value	—	—	338,460	316,283
Drugs, medicines and medicinal preparations—				
Quinine and quinine salts .. .. oz.	125,698	123,687	10,153	10,002
Medicinal oils .. cwt.	4,260	3,652	13,300	9,527
Proprietary medicines value	—	—	48,036	52,107
All other sorts .. ,,	—	—	55,395	37,995
Finished dye-stuffs obtained from coal tar cwt.	3,357	3,213	102,746	105,654
Extracts for dyeing ,,	7,350	2,518	18,115	3,877
Extracts for tanning (solid of liquid)—				
Chestnut .. cwt.	27,882	27,893	18,882	19,836
Quebracho .. ,,	6,733	4,903	6,149	4,626
All other sorts .. ,,	59,804	23,371	45,130	18,543
All other dyes and dyestuffs .. .. cwt.	627	289	13,295	7,476
Painters' and printers' colours and materials—				
White lead (basic carbonate) .. cwt.	6,575	5,180	10,135	7,251
Lithopone .. ,,	25,200	24,747	15,242	14,493
Ochres and earth colours cwt.	24,791	44,836	7,924	14,013
Bronze powders and other metallic pigments .. cwt.	1,753	1,641	12,854	11,766
Carbon blacks .. ,,	46,241	39,279	63,396	50,997
Other pigments and extenders .. cwt.	48,707	43,843	12,014	10,617
All other descriptions ,,	16,234	14,779	31,191	28,425
Total .. .. value	—	—	1,038,810	926,410

Exports

Acids—				
Citric .. .. cwt.	2,917	2,024	13,555	9,597
All other sorts .. value	—	—	27,701	19,677
Aluminium compounds tons	4,164	2,232	42,938	27,716
Ammonium compounds—				
Sulphate .. tons	29,823	40,966	175,918	276,779
All other sorts .. ,,	823	1,460	13,005	21,369
Bleaching materials—				
Bleaching powder (chloride of lime) .. cwt.	64,179	50,473	18,485	13,472
All other sorts .. ,,	5,077	3,824	11,347	10,803
Coal tar products—				
Cresylic acid .. galls.	241,275	154,638	43,686	24,499
Tar oil, creosote oil ,,	2,638,423	3,373,483	69,536	79,003
All other sorts .. value	—	—	26,199	13,854
Copper, sulphate of tons	2,730	2,102	58,233	36,098
Disinfectants, insecticides, etc. .. .. cwt.	33,110	25,415	69,124	58,165
Fertilisers, manufactured tons	30,893	11,483	68,284	51,980
Glycerine .. .. cwt.	11,593	5,859	51,633	21,052
Lead compounds .. ,,	16,482	13,757	29,528	19,176
Magnesium compounds tons	490	319	12,799	8,564
Potassium compounds cwt.	6,821	4,446	12,266	10,248
Salt (sodium chloride) tons	20,090	22,041	56,154	60,861
Sodium compounds—				
Carbonate, including soda crystals, soda ash and bicarbonate cwt.	343,383	411,130	68,027	82,321
Caustic .. .. ,,	229,436	126,966	89,695	66,862
Nitrate .. .. ,,	1,782	707	634	285
Sulphate, including saltcake .. .. cwt.	38,067	55,962	4,861	6,977
All other sorts .. ,,	73,937	55,164	92,539	65,608
Zinc oxide .. tons	1,536	1,223	37,336	22,883
All other descriptions value	—	—	236,092	203,843
Drugs, medicines and medicinal preparations—				
Quinine and quinine salts .. .. oz.	72,622	130,916	8,303	13,403
Proprietary medicines value	—	—	104,215	106,107
All other descriptions value	—	—	153,598	148,663
Dyes and dye-stuffs and extracts for tanning—				
Finished dye-stuffs obtained from coal tar—				
Alizarine, alizarine red and indigo (synthetic) cwt.	1,779	521	12,778	6,729
Other sorts .. ,,	9,210	5,882	109,920	82,292
Extracts for tanning (solid or liquid) cwt.	24,924	15,247	23,156	14,714
All other descriptions ,,	2,612	1,567	11,882	8,822
Painters' and printers' colours and materials—				
Ochres and earth colours cwt.	19,902	13,506	14,535	12,841
Other descriptions ,,	21,570	17,862	38,051	38,182
White lead .. ,,	3,441	8,344	8,100	17,208
Ships' bottom compositions cwt.	4,681	2,760	16,770	9,526
Paints and painters' enamels .. .. cwt.	51,826	35,954	140,706	99,494
Varnish and lacquer (clear) .. .. galls.	100,185	75,361	36,897	29,863
Printers' ink .. ,,	4,600	3,719	25,836	20,375
All other descriptions ,,	56,773	39,202	102,713	71,296
Total .. .. value	—	—	2,135,035	1,891,267

Re-Exports

Chemical manufactures and products .. value	—	—	21,575	17,578
Drugs, medicines and medicinal preparations cwt.	—	—	12,694	14,618
Dyes and dye-stuffs and extracts for tanning cwt.	2,062	246	3,043	983
Painters' and printers' colours and materials cwt.	283	1,081	577	3,412
Total .. .. value	—	—	37,889	36,591

Low Grade Gold Ores

A New Method of Assay

A NEW method for the quantitative estimation of good in poor grade gold lodes was described by S. K. Roy and K. K. Dutta, in a paper read before the recent 25th Indian Science Congress.

The rusty brown, poor grade pyritic gold-quartz ores of Lowa in the Manbhum district, India, did not respond satisfactorily to the known methods of assaying gold given in literature, excepting to the dry assay, and the use of dry assay is precluded by its prohibitive cost. The new method, however, entails a combination of well-known wet and dry procedure and has been found to be useful to accurately determine the presence of even 0.1 dwt. of gold in an assay ton of sample. Bromine and chlorine which dissolve gold easily are utilised as solvents. Previously roasted pyritic gold ore in contact with bromine water reacts as follows—

$$2Au + 3Br_2 = 2AuBr_3$$

Bromine is replaced by chlorine by the use of potassium permanganate and hydrochloric acid, and the gold bromide is thus changed into chloride.

$$2AuBr_3 + 3Cl_2 = 2AuCl_3 + 3Br_2$$

This gold chloride is then treated with lead acetate and zinc granules, evaporated and then scorified to give the bullion. The use of bromine may be avoided by passing chlorine gas through powdered ore moistened with water.

Precautions necessary in this new method are that the bromine must be quite in excess of the ore, and the potassium permanganate must be thoroughly dissolved in the solution. Before the hydrochloric acid is added, evaporation should be carried out on a water bath in a lead basin, and a large amount of borax should be used in the scorification.

The Chemical Age Lawn Tennis Tournament

Results of Second Round Matches

THE matches in the second round of the eighth annual CHEMICAL AGE Lawn Tennis Tournament were completed on Tuesday, and the results are given in this and following page. Except in the case of the finals, players drawn against each other must make their own arrangements for playing off the match on a court mutually agreed upon. In the event of disagreement the first name drawn (indicated by asterisk) has the right to choose the ground. The best of three advantage sets will be played in each round; except in the semi-finals and finals when the best of five sets will be played.

It is important that competitors shoud bear in mind the closing dates for the various rounds as shown at the head of each of the two draws. Results must be sent to the Editor of THE CHEMICAL AGE immediately after the match, and must in any case reach him not later than first post on the day following the final day for playing off the round.

While there will be now new draw for each successive round, a draw will be made for the right of choice of ground and competitors will be notified accordingly.

Men's Doubles

Players drawn again t each other must make their own arrangements for playing off their match on a court mutually agreed upon. In the event of disagreement the first drawn shall have the right to choose the ground, The asterisk (*) indicates the first name drawn. Best of three advantage sets, except in the case of the semi-finals and final.

FIRST ROUND **Results to be notified by May 30**	SECOND ROUND Results by June 20	THIRD ROUND Results by July 11	SEMI-FINAL Results by August 16	FINAL September 3
Clifford Thedford and Idris Williams	....bye.....	*Gough and Williams 6-2, 6-4		
T. P. Williams and C. C. Gough.....	.....bye.....			
J. W. Parkes and E. J. Allday.....	.....bye.....	Hammond and Giltrow, w.o.		
*G. F. Hammond and L. Giltrow..... Ronald Porter and Maurice King....	*Hammond and Giltrow 7-5, 1-6, 8-6.....			
*W. R. Lewis and S. Barnes..... R. J. Sleap and F. Darton.....	*Sleap and Darton 6-3, 2-6, 6-1.....	*Sleap and Darton 6-4, 6-3		
*J. I. T. Jones and R. M. O. Williams G. Haughton and W. Wakeman.....	Haughton and Wakeman w.o.....			
*A. S. Marcar and F. G. Crosse..... R. Hawkes and M. Barford.....	*Marcar and Crosse 6-2, 1-6, 6-3.....	Marcar and Crosse 6-1, 6-4		
*A. H. Tickner and J. S. Wilson..... L. A. Maronge and J. Hudson.....	Tickner and Wilson 7-5, 6-3.....			
*W. H. Herridge and J. S. Eastwell... J. H. Bartram and C. H. Martin.....	Bartram and Martin w.o.....	*Willshere and Grape 6-3, 6-4		
*E. G. Floyd and C. G. Copp..... A. E. C. Willshere and L. F. Grape..	*Willshere and Grape 6-3, 6-0.....			
*F. O'Connor and E. D. Lacy..... A. E. Triggs and W. Chamberlain...	Triggs and Chamberlain w.o.....	Hole and Smith w.o.....		
*G. W. Hole and C. G. Smith..... R. A. Champkin and A. A. Killick...	*Hole and Smith 6-1, 6-2.....			
*R. E. Hives and A. E. Hughes..... A. F. Eyres and W. Hoppe.....	*Eyres and Hoppe 6-3, 6-4.....	*Eyres and Hoppe 6-3, 6-3		
J. H. G. Plant and T. Bispham.....	.....bye.....			
D. G. Blow and R. J. Wood.....	.....*bye.....	Woollard and Hancock, w.o. ...		
J. K. Woollard and E. T. Hancock...	.....bye.....			

The Chemical Age Lawn Tennis Tournament

Men's Singles

Players drawn against each other must make their own arrangements for playing off their match on a court mutually agreed upon. In the event of disagreement the first name drawn shall have the right to choose the ground. The asterisk (*) indicates the first name drawn. Best of three advantage sets, except in the case of the semi-finals and final.

First Round **Results to be notified by May 30**	Second Round Results by June 20	Third Round Results by July 11	Fourth Round Results by August 2	Semi-Final Results by August 22	Final September 3
C. W. E. Walker...	.....*bye.....	*Pavitt, 6-3, 3-6, 6-4 ...			
E. Pavitt.....	..... bye.....				
A. L. Temple.....	.....*bye.....	Whittaker, w.o.			
Edwin Whittaker...	..... bye.....				
Clifford Thedford...	.....*bye.....	*Thedford, 6-2, 6-4			
C. C. Gough.....	..... bye.....				
P. A. Tunstall.....	.....*bye.....	Williams, w.o.			
T. P. Williams.....	..... bye.....				
J. W. Parkes.....	..... bye.....				
*H. G. Wyrill.....	*Wyrill, 6-1, 6-1..	*Wyrill, w.o. ...			
Ernest G. Shoyer...					
*L. F. Grape.....	Grape, 6-2, 6-4...				
F. G. Crosse.....					
*Gerald Pugh.....	*Pugh, w.o.	Pugh, 2-6, 6-4, 6-4			
J. E. Walker.....					
*J. I. T. Jones.....	*Sleap, w.o.				
R. J. Sleap.....					
*F. Darton.....	Hinchcliffe, w.o.	*Sleap, 6-2, 6-2			
P. E. Hinchliffe.....					
*W. Hoppe.....	*Hoppe, w.o.				
A. Cosgrove.....					
*A. S. Marcar.....	Eyres, w.o.	Hoppe, 6-1, 8-6 .			
A. F. Eyres.....					
*G. L. Rolfe.....	*Hammond 6-2, 6-2				
G. F. Hammond....					
*L. Giltrow.....	Giltrow, w.o. ...	*Hammond, 8-6, 10-12, 6-4			
D. G. Blow.....					
*A. W. A. Goudie...	*Goudie, 6-0, 6-1				
E. D. Lacy.....					
*A. H. Tickner.....	Tickner, 6-4, 6-2	Goudie, 6-2, 6-3			
W. Wakeman.....					
*E. A. Thomsett....	Thomsett, w.o.				
H. H. Lusty.....					
*S. E. Bones.....	*Haughton, w.o.	*Thomsett, 6-1, 9-7			
G. Haughton.....					
*Ronald Porter.....	Porter, 6-2, 4-6, 6-1				
R. A. Champkin....					
*G. W. Hole.....	*Hole, 6-2, 6-1....	Hole, 6-3, 6-2 ...			
E. T. Hancock.....					
R. M. O. Williams	*Williams, 6-1, 6-1				
J. H. G. Plant.....					
*S. Barnes.....	Bowler, w.o.	Bowler, 7-5, 9-11, 6-0			
H. Bowler.....					
*H. L. Shead.....	Hughes, 6-1, 6-1				
A. E. Hughes.....					
*R. J. Wood.....	*Copp, w.o.	*Copp, 6-4, 7-9, 6-4			
C. G. Copp.....					
*W. R. Lewis.....	*Lewis, 6-0, 6-3 ...				
J. K. Woollard.....					
A. A. Killick.....	..... bye.....	Lewis, w.o.			
L. A. Maronge.....	..... bye.....				
G. A. Hanson.....	.....*bye.....	*Hanson, 6-0, 6-1			

Personal Notes

SIR JOHN PAKEMAN has been appointed a director of the Colthrop Board and Paper Mills.

The late COLONEL D. F. D. NEILL, of Greenock, and of Keills, Ayrshire, sugar refiner, left personal estate in Great Britain, valued at £171,440.

MR. LUCIEN MILLER, of Poland, has been awarded the wool textile prize of the International Wool Textile Organisation, for his book " Fat in Wool."

The late MR. HENRY STOCKER, of Boughmead Street, St. Austell, Cornwall, china clay merchant, left estate valued £49,541, with net personalty £45,832.

MR. M. P. APPLEBY, research manager of Imperial Chemical Industries, Ltd., at Billingham, will receive the honorary degree of D.Sc. from Durham University on June 28.

PROFESSOR J. B. S. HALDANE, F.R.S., M.A., Weldon professor of biometry, University College, London, has been awarded the Weldon Memorial prize by Oxford University, for 1938.

The late MR FREDERICK JANSON HANBURY, of Brockhurst, East Grinstead, Sussex, formerly chairman of Allen and Hanbury, Ltd., left estate valued £100,136, with net personalty £36,935.

The late MR. HAROLD OSTLERE, of Marchmont, Kirkcaldy, joint managing director of Barry, Ostlere and Shepherd, linoleum manufacturers, Kirkcaldy, left personal estate in Great Britain and abroad valued at £132,680.

MR. JAMES DEWE LAMBERT, M.A., has been elected to an official fellowship at Trinity College, Oxford. Mr. Lambert was placed in the first class in natural science (chemistry) in 1934, and has been demonstrator under Professor C. N. Hinshelwood in the Trinity and Balliol laboratory.

MR. W. T. CALDERWOOD, managing director of Thomas Hedley and Co., Ltd., soap manufacturers, Newcastle, has been appointed chief superintendent of the Air Raid Precautions auxiliary fire brigade at Newcastle. He will work under the supervision of the chief of the Newcastle Fire Brigade, subject to the orders of the A.R.P. Committee.

MR. J. E. HURST, technical director of Sheepbridge Stokes Centrifugal Castings Co., Ltd., Chesterfield, has been awarded the gold medal given annually by Mr. E. J. Fox, managing director of the Stanton Coal and Iron Co., Ltd., to a scientist who has in some outstanding way contributed to the advancement of foundry practice and metallurgy.

DR. ALEXANDER R. TODD, of the Lister Institute of Preventive Medicine, has been appointed Sir Samuel Hall professor of chemistry and director of the chemical laboratories at Manchester University, in succession to Professor I. M. Heilbron, who will vacate the chair in September next. Dr. Todd graduated with first-class honours in chemistry in the University of Glasgow, in 1928, having specialised in organic chemistry. He held a Carnegie research scholarship in 1929, working in the organic chemistry department under Professor T. S. Patterson on rotatory dispersion and the Walden inversion. In 1931 he was elected to an 1851 Exhibition senior research studentship, and worked for three years in the Dyson Perrins Laboratory, at Oxford, under Professor Robert Robinson on the anthocyanin pigments of plants and on the bio-chemistry of micro-organisms. In 1934 he went to the Department of Chemistry in Relation to Medicine at Edinburgh University as assistant to Professor Barger, holding a grant from the Medical Research Council and subsequently a Beit Memorial medical research fellowship. While in Edinburgh Dr. Todd worked on the chemistry of vitamin B1 and related compounds, and on anthelmintics and other natural products. In 1936 the Institute of Chemistry and the Society of Maccabæans awarded him the Meldola medal.

SIR LOUIS SMITH, M.P., who received his knighthood in the recent Birthday Honours, is one of the leading personalities in the fertiliser industry. He is chairman of Dougnty-Richardson Fertilisers, Ltd., of Lincoln, with which company Quibell Bros., Ltd., of Newark, Hammonds, of Boston, and Harts, of Keadby, are associated. He also serves the interest in Lincolnshire of the parent company, Fison, Packard and Prentice, Ltd., of Ipswich, of which company he is a director. Sir Louis is a Member of Parliament for the Hallam Division of Sheffield. He first became associated with the fertiliser industry in 1923, when he commenced the re-organisation and re-construction of the old established business of Doughty, Son and Richardson, Ltd., whose management reaped the benefit of his business acumen and skilful direction. In 1932 he was elected president of the Fertilisers Manufacturers' Association, Ltd., in which office he remained for two years, doing meritorious work on behalf of the association.

Sir Louis Smith M.P.

OBITUARY

MR. THOMAS L. CHADBOURNE, author of the plan for limiting the world's sugar production, died in New York, on June 16, at the age of 66. Mr. Chadbourne was a lawyer and acted as counsel for leading American sugar interests.

MR. WILLIAM CROSBY, a former managing director and deputy chairman of Edgar Allen and Co., Ltd., has died at his home in London, at the age of 74. He established the South African business of the firm in 1894, became a director in 1900, and retired in 1930.

DR. CHARLES EDOUARD GUILLAUME, who has been director since 1915 of the International Bureau of Weights and Measures in Paris, has died at Geneva. He was known for his invention of invar, an alloy of iron and nickel, and of another alloy of iron, nickel, and chromium called elinvar. He was awarded the Nobel prize in 1920 for his scientific studies.

Ten Years Back

From " The Chemical Age," June 23, 1928

Synthetic camphor is to be produced on a large scale by a French company, the Société Alsacienne de Produits Chimiques.

* * * *

The King has approved of the following title being taken by Sir Alfred Mond: Baron Melchett, of Landford, in the county of Southampton.

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From Week to Week

THE INSTITUTE OF PATENTEES will hold their exhibition of inventions at the Central Hall, Westminster, London, S.W.1, October 5 to 15 inclusive.

MUREX WELDING PROCESSES, LTD., have moved to new offices and works at Hertford Road, Waltham Cross, Herts. Telephone No.: Waltham Cross 1050.

THE TREASURY HAS MADE AN ORDER under Section 10 (5) of the Finance Act, 1926, exempting α-naphthylisothiocyanate from Key Industry Duty from June 22 until December 31, 1938.

THE 14TH INTERNATIONAL WOOL CONFERENCE was concluded in London, on June 17. Next year the conference will be held in Brussels, at the invitation of the Belgian delegates, and in 1940 it will meet in Prague.

REDFERN'S RUBBER WORKS, LTD., of Hyde, Cheshire, have decided to pay one week's wages at the standard rate for the Wakes holiday week to all wage-earning employees who have been in the company's service for the previous twelve months.

ONE PERSON IN A HUNDRED is liable to contract dermatitis as a result of their experience in the gas chamber during Air Raid Precaution training, stated Mr. J. H. Hodges, one of the speakers at the recent conference of the Post Office Engineering Union.

ELI LILLY AND CO., the large drug manufacturers of Indianapolis, United States, will enter the foreign manufacturing field early in 1939, after the completion of a contemplated factory at Basingstoke, in England, which will include extensve biological laboratories.

B.E.N. PATENTS, LTD., recently received a letter addressed to "Big Ben Spraying Co., Ltd., London." The letter was posted in Plymouth on June 6, and reached the company on June 8. They feel that the prompt delivery of the letter was due in no small measure to the valuable publicity gained from consistent advertising.

THE GEIGY COLOUR CO., LTD., have introduced a new bright and pure blue of very good yield, for the dyeing of bright and dulled acetate rayon. This Setacyl Direct Blue 4GS Supra is brighter and greener in shade than their Setacyl Direct Blue 2GS brand and possesses increased fastness to light, especially in medium and heavy shades.

THE NEWLY-FORMED NATIONAL FEDERATION OF IRON AND STEEL MERCHANTS held meetings at the Hotel Victoria, London, on June 17, when the constitution of the organisation was formally adopted. Sir Walter Jenkins was appointed independent chairman of the Federation. Mr. Ernest B. Hall, chairman of the National Association of Iron and Steel Stockholders, was elected president.

THE IMPORTS OF GREATER GERMANY, including Austria, during May, amounted to Rm.516,000,000, an increase of Rm.39,100,000, or 8.2 per cent., compared with April. Exports amounted to Rm.465,500,000, an increase of Rm.13,500,000, or 3 per cent., on the preceding month. The increase in imports is due primarily to the larger supplies of raw materials and livestock brought into the country.

ACCORDING TO A REPORT on Economic and Commercial Conditions in Iraq, issued for the Department of Overseas Trade by H.M. Stationery Office (price 1s.), imports into Iraq from the United Kingdom in 1937 totalled 2,826,000 dinars (a percentage of 30 per cent.) as compared with 2,272,000 dinars in 1936. Exports to this country in the same years were 1,548,000 dinars and 1,063,000 dinars respectively, revealing percentages of 28 per cent. and 30 per cent. United Kingdom imports have increased steadily over the last 3 years.

ACETYLENE GAS to the quantity of 158,000 cubic feet are used every year in the L.N.E.R. works at Gorton for welding and cutting purposes. Most of this gas has hitherto been obtained from seven portable generators, the remainder being purchased in dissolved form. Arrangements have now been made to instal a central generating plant with a suitable pipe line system with hydraulic safety and isolating valves. When the new generating system has been installed the portable generators will be utilised elsewhere.

THE ASSOCIATION OF BRITISH INSECTICIDE MANUFACTURERS have elected at the annual general meeting, the following officers and executive committee to serve for the year 1938-39: Chairman: L. F. Braga (Plant Protection, Ltd.); hon. treasurer: H. J. Jones (Hemingway and Co., Ltd.); hon. auditor: R. A. Blair (Burt, Boulton and Haywood, Ltd.); executive committee: R. A. Blair (Burt, Boulton and Haywood, Ltd.), W. V. Blewett (Imperial Chemical Industries, Ltd.), E. Z. Bolt (G. H. Richards, Ltd.), R. V. Craven (W. J. Craven and Co., Ltd.), J. S. Mitchell (Murphy Chemical Co., Ltd.), J. H. Reid (British Nicotine Co., Ltd.); secretary: J. Davidson Pratt.

THE SUPPLEMENT TO "CIBA REVIEW" relates to dyed shades fast to sea water. Copies can be obtained from the Society of Chemical Industry in Basle, Basle, Switzerland.

THE OXY-ACETYLENE WORKS of the British Oxygen Co., Ltd., at Jarrow, which have been rebuilt following the explosion in February are now again in production.

TWENTY-NINE DANISH CHEMICAL ENGINEERING STUDENTS from the Royal Polytechnic School, Copenhagen, arrived in London on June 18, to begin a tour of industrial and scientific centres.

AN ALUMINIUM WIRE so fine that 10,000 pieces laid side by side would measure only one inch in width, is being exhibited at the Glasgow Empire Exhibition. This exhibit weighs 0.000000009246 pounds per foot length.

PRODUCTION OF HELIUM from the atmosphere was claimed by Dr. Siedler, of Frankfurt-on-Main, at the annual meeting of chemists at Bayreuth. Dr. Siedler said the impurity of helium thus produced was only 1 per cent.

ON BEHALF OF THE COPPER PRODUCING COMPANIES operating under the output restriction scheme it is officially announced that as from July 1 production will be decreased from 100 to 95 per cent. of the agreed basic tonnages.

THE CONSETT IRON CO., LTD., is making arrangements for taking over the site for the new steelworks at Jarrow and for forming a new Jarrow steel company. The Consett Iron Co. is to provide £200,000 of the capital, which will amount to £1,000,000.

AN AGREEMENT HAS BEEN REACHED between the Durham County Cokemen's Association and the newly-formed Coke Oven's Association which will result in holidays with pay for employees, a shorter working week and the creation of more employment. The agreement will affect most of the coke-oven plants in county Durham. Hours are reduced from 56 to 48 weekly.

J. M. STEEL AND CO., LTD., are suppliers of a range of special plasticisers, which include Desavin, an unsaponifiable plasticiser also for use with unsaponifiable binding media. This product has been developed for chlorinated rubber and very small additions produce remarkable elasticity of the chlorinated rubber film, considerably better than the best of even the saponifiable plasticisers (such as dibutyl phthalate) hitherto available.

THE SANITARY INSPECTORS' ASSOCIATION will hold their 51st annual conference at Edinburgh, September 5 to 10. The proceedings will include discussions on "Food and Drugs Legislation," "The Laboratory Control of Milk Supply," and "Disposal of Trade Effluents." There will also be a lecture on "Atmospheric Pollution with Special Reference to Sulphur and Grit," by Dr. Birket Wylam, Esq., M.I.Chem.E., F.I.C., Chief Alkali Inspector, Scotland.

THE ROYAL EYE HOSPITAL at St. George's Circus, Southwark, held an exhibition of devices for the prevention of industrial eye injuries this week. Among the protective devices in the exhibition were wire-faced masks to protect the eyes of workers in mineral-water factories and breweries where, under certain conditions, bottles are apt to burst under pressure; guards fitted with celluloid for workers at grinding wheels; and respirators for men doing such jobs as spraying with cellulose.

THE OFFICES OF THE IRON AND STEEL INSTITUTE and of the Institute of Metals will be moved to 4 Grosvenor Gardens, London, S.W.1, as from July 1, 1938. The Institutes will occupy separate offices in this house, but will share committee and reading rooms. Correspondence should be addressed to the secretary of the Institute concerned. Telephone numbers and telegraphic address: The Iron and Steel Institute, Sloane 0061, "Irosamente, Sowest, London," and The Institute of Metals, Sloane 6233, "Sloane 6233, London."

Books Received

Tables for Qualitative Analysis. By James Bruce and Harry Harper. London: Macmillan and Co., Ltd. Pp. 29. 8d.

An Introduction ot Microchemical Methods. By Cecil L. Wilson. London: Methuen and Co., Ltd. Pp. 196. 7s. 6d.

Chemical Engineering Group. Proceedings, Vol. XIX 1937. London: Chemical Engineering Group. Pp. 138. 21s.

The Humidity of the Air. By Charles L. Burdick. London: E. and F. N. Spon, Ltd. Pp. 20. 1s.

Official Methods of Analysis of the International Society of Leather Trades' Chemists. London: A. Harvey. Pp. 164. Members of the I.S.L.T.C. 5s. Non-members 8s. 6d.

Inventions in the Chemical Industry

The following information is prepared from the Official Patents Journal. Printed copies of Specifications accepted may be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, at 1s. each. The numbers given under "Applications for Patents" are for reference in all correspondence up to the acceptance of the Complete Specification.

Applications for Patents

ALUMINIUM ALLOYS.—Association Co-operative d'Ouvriers en Materiel Electrique, and J. Hanco. (March 11.) 16847.

CATALYSTS.—R. Auchter. (Germany, June 7, 37.) 16860; (Germany, Dec. 13, '37.) 16861.

MANUFACTURE OF MELAMINE.—A. G. Bloxam. (Switzerland, June 5, '37.) 16879.

ALUMINIUM-BASE ALLOYS.—British Aluminium Co., Ltd., and H. G. Dyson. 16839.

MANUFACTURE OF CONDENSATION PRODUCTS.—British Celanese, Ltd. (United States, June 9, '37.) 16890.

HIGH-TENSILE STEEL ALLOYS.—British Rolling Mills, Ltd., and G. B. Morrison. 16794.

SYNTHETIC RESINS.—British Thomson-Houston Co., Ltd. (United States, June 25, '37.) 17066.

MANUFACTURE OF DIPARADIAMINODIPHENYLSULPHONES.—A. Carpmael (I. G. Farbenindustrie.) (Dec. 21, '37.) 16598.

MANUFACTURE OF HALOGENATED AMINOSULPHONES.—A. Carpmael (I. G. Farbenindustrie.) (Dec. 21, '37.) 16599.

PRODUCTION OF ALKALINE ESTERS.—Chemische Fabriken Dr. J. Wiernik and Co., A.-G. (Germany, June 5, '37.) 16750.

PERMANENT MAGNET STEEL.—Deutsche Edelstahlwerke, A.-G. (Germany, June 3, '37.) 16561.

PRODUCTION OF AMMONIUM SULPHATE.—Directie van de Staatsmijnen in Limburg. (Holland, June 9, '37.) 17030.

AMINOBENZYL-ACYLAMINES.—J. R. Geigy, A.-G. (Switzerland, June 3, '37.) 16541.

PRODUCTION OF DISPERSIONS.—A. S. Gomm, and Imperial Chemical Industries, Ltd. 16892.

COPPER-ALUMINIUM ALLOY.—H. C. Hall, and H. E. Gresham. 16665.

RECOVERY OF ODOURLESS SOAP-FORMING FATTY ACIDS.—I. G. Farbenindustrie. (Germany, June 2, '37.) 16582; (Germany, June 2, '37.) 16583; (Germany, Dec. 27, '37.) 16584; (Germany, Dec. 28, '37.) 16585.

MANUFACTURE OF PHTHALOCYANINE SULPHONIC ACID CHLORIDES. I. G. Farbenindustrie. (Germany, June 8, '37.) 17071.

PRODUCTION OF ZEIN SOLUTIONS.—International Patents Development Co. (United States, July 26, '37.) 16764.

MANUFACTURE, ETC., OF BUTADIENE.—G. W. Johnson (I. G. Farbenindustrie.) 16586.

APPARATUS FOR THE ELECTROLYTIC DECOMPOSITION OF ALKALI COMPOUNDS, ETC.—G. W. Johnson (I. G. Farbenindustrie.) 16917, 16918.

MANUFACTURE OF HYDROCARBON GASES.—T. D. Kelly. 16673.

MANUFACTURE OF LEAD COMPOUNDS.—B. H. Marsh, and D. W. Marsh. 17085.

PREPARATION OF THERAPEUTICALLY USEFUL HETEROCYCLIC COMPOUNDS.—May and Baker, Ltd., A. J. Ewins, and N. A. Phillips. 17042.

PREPARATION OF THERAPEUTICALLY-USEFUL HETEROCYCLIC COMPOUNDS.—May and Baker, Ltd., and G. Newbery. 16719.

PROCESS FOR RECOVERY OF ZINC from zinciferous material in shaft furnaces, etc.—Metallges, A.-G. (Germany, June 12, '37.) 16601.

CONCENTRATION OF MINERALS by froth flotation.—Minerals Separation, Ltd. (United States, June 5, '37.) 16754; (United States, Dec. 18, '37.) 16755.

PRODUCTION OF STABLE CONCENTRATED SOLUTIONS of the salts of iodohippuric acid.—Naamlooze Vennootschap Orgachemia. (Holland, June 3, '37.) 16605.

MANUFACTURE OF AROMATIC AMINOBENZENE-SULPHONIC ACID NITROARYLIDES.—A. van. Raalte. 17016.

MANUFACTURE OF PYRIMIDINE COMPOUNDS.—Research Corporation. (June 2, '37.) (United States, June 15, '36.) 17092; (June 2, '37.) (United States, Aug. 5, '36.) 17093.

MANUFACTURE OF KETOSTEROIDS.—Schering, A.-G. (Germany, June 3, '37.) 16594; (Germany, Dec. 30, '37.) 16595.

PRODUCTION OF POLYMERISATION PRODUCTS.—Siemens and Halske, A.-G. (Germany, June 7, '37.) 16962; (Germany, June 7, '37.) 16963.

MANUFACTURE OF KETONES, ETC.—Soc. of Chemical Industry in Basle. (Switzerland, June 5, '37.) 16967; (Switzerland, Aug. 16, '37.) 16968; (Switzerland, April 22.) 16969.

PRODUCTION OF CERAMIC DIELECTRICS.—Steatite and Porcelain Products, Ltd., and N. O. Clark. 17029.

VAPORISATION OF OIL.—G. K. Stone. 16736.

PRODUCTION OF OXIDATION PRODUCTS of hydrocarbons of high molecular weight.—W. H. A. Thiemann (Farenholtz and Hubbe). 17086.

PRODUCTION OF OLEFINE OXIDES.—United States Industrial Alcohol Co. (United States, June 24, '37.) 16693.

VULCANISATION OF RUBBER.—Wingfoot Corporation. (United States, Sept. 23, '37.) 17003.

NON-FERROUS ALLOYS.—Yorkshire Copper Works, Ltd., and K. Fraser. 16551.

RECOVERY OF NITROGEN from the atmosphere.—Birmingham Aluminium Casting (1903) Co., Ltd., and N. A. Clark. 17756.

MANUFACTURE OF VARNISHES, ETC.—H. V. A. Briscoe. 17203.

Specifications Open to Public Inspection

HYDROGENATION OF NAPHTHYLAMINES.—Imperial Chemical Industries, Ltd. Dec. 5, 1936. 33747/37.

RUBBER COMPOSITIONS and methods of forming the same.—Firestone Tyre and Rubber Co., Ltd. Dec. 10, 1936. 10408/37.

PRODUCTION OF PHENOL-ALDEHYDE SYNTHETIC RESINS.—Bakelite Ltd. Dec. 12, 1936. 24331/37.

TREATMENT OF MINERAL PHOSPHATES.—Chemische Studien-Ges. Uniwapo Ges. Dec. 9, 1936. 27196/37.

MANUFACTURE OF RUBBERLIKE PRODUCTS.—Standard Oil Development Co. Dec. 11, 1936. 29219/37.

VAT DYESTUFFS.—E. I. du Pont de Nemours and Co. Dec. 7, 1936. 31269/37.

ALUMINIUM ALLOYS.—I. G. Farbenindustrie. Dec. 11, 1936. 32143/37.

INSULATING-COATINGS FOR METALLIC SHEETS and methods of forming the same.—Sterling Varnish Co. Dec. 9, 1936. 32888/37.

MANUFACTURE OF UREA.—Compagnie de Produits Chimiques et Electrometallurgiques Alais, Froges, et Camargue. Dec. 9, 1936. 33032/37.

PROCESS FOR DEHYDRATION OF MIXTURES of carbon-dioxide and ammonia.—Compagnie de Produits Chimiques et Electrometallurgiques Alais, Froges, et Camargue. Dec. 11, 1936. 33033/37.

MOTOR-FUEL.—O. Bormann. Dec. 8, 1936. 33126/37.

TANNING-MATERIAL AND PROCESS FOR THE MANUFACTURE THEREOF. G. Bosio, F. Bosio, and G. Baggini. Dec. 12, 1936. 33827/37.

PRODUCTION OF SYNTHETIC RESINS.—Bakelite, Ltd. Dec. 9, 1936. 33899/37.

MANUFACTURE OF ACID WOOL DYESTUFFS.—I. G. Farbenindustrie. Dec. 12, 1936. 34020/37.

METHOD OF AND APPARATUS FOR DISTILLATION.—A. D. Little, Inc. Dec. 9, 1936. 34025/37.

WHITE OPACIFIERS FOR ENAMELS and glazes.—Deutsche Gold- und Silber-Scheideanstalt Vorm. Roessler. Dec. 9, 1936. 34119/37.

PROCESS FOR THE PRODUCTION OF CERIUM COMPOUNDS.—Deutsche Gold-und Silber-Scheideanstalt Vorm. Roessler. Dec. 10, 1936. 34298/37.

MANUFACTURE OF PYRIMIDINE COMPOUNDS.—Research Corporation. June 15, 1936. 17092/37.

Specifications Accepted with Dates of Application

MANUFACTURE AND PRODUCTION OF ALKALI CELLULOSE.—Courtaulds, Ltd., W. H. Stokes, and E. A. Morton. March 31, 1937. 486,243.

PRODUCTION OF NUCLEOSIDES.—C. E. Every (Henning, Chem. Pharm. Werk. Ges. Dr. G.). July 8, 1937. 486,366.

PRODUCTION OF BUTADIENE.—I. G. Farbenindustrie. July 24, 1936. 486,264.

RECOVERY OF LOWER-ALIPHATIC ACIDS.—Soc. Des Usines Chimiques Rhone-Poulenc. Nov. 11, 1936. 486,488.

METHOD FOR REGULATING THE TEMPERATURE in the treatment of carbonaceous materials with hydrogenating gases to produce valuable hydrocarbon products.—H. E. Potts (International Hydrogenation Patents Co., Ltd.). Sept. 11, 1937. 486,492.

PROCESS FOR THE MANUFACTURE OF ACID SODIUM FLUORIDE.—Seri Holding Soc. Anon. Oct. 15, 1936. 486,380.

PROCESS FOR THE MANUFACTURE OF 2-METHYL-4-AMINO-5-CYANOPYRIMIDINE.—F. Hoffman-La Roche and Co., A.-G. Feb. 24, 1937. 486,414.

DISTILLATION OF GLYCERIN.—Colgate-Palmolive-Peet Co. Dec. 23, 1935. (Divided out of 486,311.) 486,415.

METHOD OF AND MEANS FOR CASTING INGOTS FROM ALLOYS OF ALUMINIUM.—W. Roth. March 28, 1938. 486,420.

PROCESS FOR THE MANUFACTURE OF SULPHONIC ACID AMIDE COMPOUNDS.—A. Carpmael (I. G. Farbenindustrie.) (Aug. 29, 1936. (Divided out of and addition to 486,421.) 486,497.

TREATMENT OF TIN AND TIN ALLOYS and articles made therefrom or coated therewith to protect same against corrosion or chemical action.—Sir J. Campbell, D. J. Macnaughton, and R. Kerr. Nov. 9, 1936. 486,752.

PREPARATION OF CELLULOSE ESTERS.—V. M. Hammerschlag. Aug. 29, 1936. 486,755.

MANUFACTURING A STABLE ORGANIC FERRO-COMPOUND.—F. B. Dehn (Chemische Fabrik Promonta Ges.). Sept. 9, 1936. 486,757.

MANUFACTURE OF CONDENSATION PRODUCTS from aminotriazines. A. G. Bloxam (Soc. of Chemical Industry in Basle). Oct. 28, 1936. 486,519.

PRODUCTION OF ORGANIC PHOSPHOROUS COMPOUNDS.—Celluloid Corporation. Nov. 20, 1935. 486,760.

PRODUCING SUPERPHOSPHATE FERTILISERS and product thereof. L. H. Facer. Nov. 4, 1936. 486,587.

PRODUCTION OF CONDENSATION PRODUCTS of aromatic hydrocarbons with mono-olefines.—Distillers Co., Ltd., H. M. Stanley, G. Minkoff, and J. E. Youell. Oct. 30, 1936. 486,520.

PRODUCING WASHING, EMULSIFYING, AND DISPERSING AGENTS.—F. Steinfels, A.-G. Nov. 5, 1935. 486,850.

MANUFACTURE OF DYESTUFFS.—Soc. of Chemical Industry in Basle. Nov. 6, 1935. (Samples furnished.) 486,660.

MANUFACTURE OF CELLULOSE DERIVATIVES containing nitrogen. H. Dreyfus. Dec. 3, 1936. 486,527.

METHOD OF FIREPROOFING INFLAMMABLE MATERIALS.—Ruhrchemie, A.-G. Dec. 4, 1935. 486,766.

ELECTRICAL INSULATING MATERIALS.—Bushing Co., Ltd., and W. J. Brown. Dec. 4, 1936. 486,534.

MANUFACTURE OF POLYMERIC PRODUCTS OF ACETYLENE.—W. W. Groves (I. G. Farbenindustrie.) Dec. 5, 1936. 486,918.

PROCESS FOR THE MANUFACTURE OF COMPOUNDS of the androstane and pregnane series.—Schering-Kahlbaum, A.-G. Dec. 7, 1935. (Samples furnished.) 486,854, 486,596.

IMPROVING IRON AND STEEL AND ALLOYS.—C. E. Every (P. Ferchland). Dec. 7, 1936. 486,857.

ELECTRO-THERMIC PRODUCTION OF MAGNESIUM.—American Magnesium Metals Corporation. Jan. 10, 1936. 486,558.

MANUFACTURE OF ORGANIC ESTERS.—E. I. du Pont de Nemours and Co. Dec. 13, 1935. 486,560.

TREATMENT OF COPALS, amber, and similar resins.—E. Asser, and T. Ruth (trading as Gustax Ruth Temperolwerke Chemische und Lack-Fabriken). Dec. 7, 1935. 486,923.

MANUFACTURE OF PYRENE-CARBOXYLIC ACIDS and alkylarylcarbamylpyrenes.—G. Sheldrick, M. Wyler, and Imperial Chemical Industries, Ltd. Dec. 8, 1936. 486,668.

MANUFACTURE OF ORGANIC ACIDS.—E. I. du Pont de Nemours and Co. Dec. 13, 1935. 486,669.

PRODUCING TEXTILE MATERIALS containing synthetic condensation products.—Tootal Broadhurst Lee Co., Ltd., A. E. Battye, J. Tankard, and F. C. Wood. Dec. 9, 1936. 486,926.

CATALYTIC CONVERSION OF CARBON MONOXIDE into higher hydrocarbons by means of hydrogen.—Ruhrchemie, A.-G. Dec. 10, 1935. 486,928.

MANUFACTURE AND PRODUCTION OF HETEROCYCLIC NITROGEN COMPOUNDS containing aldehyde groups.—G. W. Johnson (I. G. Farbenindustrie.) Dec. 9, 1936. 486,780.

MANUFACTURE OF PHTHALOCYANINE COMPOUNDS.—M. Wyler, and Imperial Chemical Industries, Ltd. Dec. 9, 1936. 486,782.

HYDRATION OF OLEFINES.—E. I. du Pont de Nemours and Co. Dec. 13, 1935. 486,783.

SEPARATING ELEMENTS FROM THEIR ORES OR COMPOUNDS.—H. A. Blackwell, and W. L. Turner. Dec. 10, 1936. 486,930.

METHOD OF PRODUCING SOLUTIONS OF COMPOUNDS of high molecular weight.—I. G. Farbenindustrie. Jan. 17, 1936. 486,864.

MANUFACTURE OF ORTHO-OXY-AZO-DYESTUFFS.—I. G. Farbenindustrie. Jan. 17, 1936. 486,865.

ORGANIC PROCESSES employing boron-halogen-containing compounds.—E. I. du Pont de Nemours and Co. Dec. 13, 1935. 486,877.

PROCESS FOR THE MANUFACTURE OF RUBBER CONVERSION PRODUCTS.—I. G. Farbenindustrie. Dec. 11, 1935. 486,878.

BITUMINOUS MATERIALS.—Standard Oil Development Co. Feb. 27, 1936. 486,932.

PREPARATION OF DISUBSTITUTED BARBITURIC ACIDS.—E. Lilley and Co., and H. A. Shonle. Dec. 11, 1936. 486,934.

SEPARATION OF THE CONSTITUENTS OF ORGANIC ADDITION COMPOUNDS.—E. I. du Pont de Nemours and Co. Dec. 13, 1935. 486,886, 486,563, 486,887.

MANUFACTURE OF MOULDING COMPOSITIONS containing condensation products of the phenol-aldehyde type.—E. Elbel. Dec. 11, 1935. 486,890.

MANUFACTURE OF SUBSTANCES RESEMBLING VITAMINS from plants. W. W. Groves (I. G. Farbenindustrie.) Dec. 12, 1936. 486,898.

MANUFACTURE OF REFRACTORY MATERIALS.—H. H. Chesny, and A. L. Bradley. Dec. 12, 1936. 486,899.

ACETYLATION PROCESS FOR CELLULOSE FIBRES and fabrics.—A. C. Thaysen. Dec. 14, 1936. 486,901.

VOLTOLISATION OF HYDROCARBON OILS.—Standard Oil Development Co. Jan. 2, 1936. 486,902.

MANUFACTURE OF ARTIFICIAL RESINS.—H. D. Elkington (Hungarian Rubber Goods Factory, Ltd. (Magyar Ruggyantaarugyar Reszvenytarsasag)). Dec. 19, 1936. 486,611.

MANUFACTURE OF CELLULOSE DERIVATIVES.—H. Dreyfus. Dec. 21, 1936. 486,564.

MANUFACTURE OF ORTHO-OXYAZO-DYESTUFFS.—I. G. Farbenindustrie. June 3, 1936. 486,904.

FUNGICIDES AND METHOD OF MAKING SAME.—A. D. Amico. Feb. 16, 1937. 486,621.

TREATMENT OF MATERIALS containing tantalum and/or niobium. W. W. Triggs (Soc. Generale Metallurgique de Hoboken). March 19, 1937. 486,693.

METHOD FOR PRODUCING A HEAT-INSULATING MATERIAL OUT OF GLASS.—V. Straka, B. Weiner, and J. Kloubek. April 1, 1937. 486,623.

MANUFACTURE OF FERROUS ALLOYS.—Fonderies Francaises D'Aciers Speciaux Inoxydables. March 12, 1937. 486,908.

MAKING BORON CARBIDE.—Norton Grinding Wheel Co., Ltd. June 10, 1936. 486,817.

SOAP PRODUCTS and the manufacture thereof.—Lever Bros., Ltd. June 18, 1936. 486,819.

SEPARATING LOWER ALKYLAMINES.—L. N. Reddie (Girdler Corporation). June 17, 1937. 486,821, 486,822.

PRODUCING WASHING, EMULSIFYING and dispersing agents.—F. Steinfels, A.-G. Nov. 5, 1936. 486,909.

MOTOR FUELS.—Standard Oil Development Co. Aug. 15, 1936. 486,631.

MANUFACTURE OF ARYL SUBSTITUTED MONO-OLEFINES and derivatives thereof.—Distillers Co., Ltd., H. M. Stanley, G. Minkoff, and J. E. Youell. Oct. 30, 1936. 486,573.

PRODUCTION OF ARYL SUBSTITUTED MONO-OLEFINES.—Distillers Co., Ltd., H. M. Stanley, G. Minkoff, and J. E. Youell. Oct. 30, 1936. 486,574.

MANUFACTURE OF PYRAZOLONE DERIVATIVES.—Soc. of Chemical Industry in Basle. Nov. 6, 1935. 486,747.

MANUFACTURE OF CONDENSATION PRODUCTS from aminotriazines.—A. G. Bloxam (Soc. of Chemical Industry in Basle). Oct. 28, 1936. 486,577.

Chemical and Allied Stocks and Shares

GENERAL conditions in the stock and share markets have improved since the beginning of the new Stock Exchange account on Monday. There was not much increase in the volume of business, but dealers sent out higher prices in anticipation of active markets if, as is hoped, sentiment has the benefit of a definite easing of tension in international affairs. The better showing of Wall Street markets and the firmer tendency of metal and commodity prices were other factors which had a helpful influence.

Shares of chemical and kindred companies have responded to the improved market conditions. In most cases they have a large following and usually move rather closely with the surrounding trend of the Stock Exchange. Imperial Chemical are 31s. 6d. at the time of writing, compared with 29s. 7½d. a week ago, while Turner and Newall have improved from 77s. 9d. to 78s. 3d. and Lever and Unilever from 37s. to 37s. 10½d. British Oxygen have been in better request following a further reaction and are 69s. 4½d. compared with 65s. a week ago. At the moment, however, the tendency is to await the terms of the proposed issue of preference shares, which are expected to be announced on 4th July, when the meeting of shareholders is called to sanction the increase in capital.

British Plaster Board were active around the rather higher level of 27s., hopeful dividend estimates having continued in the market. Associated Cement at 81s. 3d. were considerably higher at 81s. 3d., as were British Portland Cement, which are also 81s. 3d. B. Laporte transferred around 82s. 6d. British Match were better at 32s. 3d., and Wall Paper deferred units made the improved price of 35s.

Sangers were steady at 21s. 3d., awaiting publication of the full results, while Boots Pure Drug have moved up from 39s. 9d. to 41s. 9d. on further consideration of the statements at the meeting, which are regarded by some market men as indicating that there is a reasonable possibility of a special bonus of some kind when general trading conditions are more stable. British Drug Houses were again 22s. 6d. and Timothy Whites and Taylors remained at 25s.

General Refractories at 12s. 6d. were unchanged on balance. Fison Packard and Prentice at 33s. 9d., and Cooper McDougall and Robertson at around 29s. were again steady features, as were United Glass Bottle at 45s. Triplex Safety Glass responded strongly to the better general market conditions and are 40s. at the time of writing, which compares with 37s. 6d. a week ago. Beechams Pills were higher at 50s. British Oil and Cake Mills preferred shares were again steady around 43s. 6d., and United Premier Oil and Cake ordinary shares at 7s. 3d. are also virtually the same as a week ago. International Combustion, although now "ex" the interim dividend have been well maintained at 92s. 6d.

Dorman Long, Consett Iron, Guest Keen and various other prominent iron and steel shares have moved moderately in favour of holders, further attention drawn to the attractive yields offered having tended to bring in buyers. Stanton Ironworks were steady at 44s. on the past year's results. Elsewhere General Electric were an active feature on further consideration of the financial results.

Oil shares have responded to the better general market conditions. Anglo-Iranian were active around 85s. 7½d., aided by the favourable impression created by the statements at the meeting and "Shell" made the higher price of 86s. 10½d.

Weekly Prices of British Chemical Products

THE demand for general chemicals during the past week has been somewhat subdued, business being more or less confined to transactions of a day-to-day character. One or two items have enjoyed a fair seasonal trade, but the volume of inquiry for weed killers and the potash and soda products generally has been rather disappointing and in some quarters ex-contract deliveries are reported to be behind schedule. There are no important price changes to report for general chemicals, rubber chemicals and wood distillation products, values remaining steady throughout. There is as yet no indication of any improvement in the market for coal tar products. A certain amount of buying has been in progress chiefly for small parcels to meet immediate or nearby requirements, but there is certainly no substantial buying in any direction. So far as values are concerned the tendency is for prices to be easier but, as has been stated frequently in this report for some months past, quotations in the absence of firm buying orders must be regarded as nominal.

MANCHESTER.—Although the undertone on the Manchester chemical market during the past week has been slightly more cheerful, quiet conditions are reported in most sections so far as actual business is concerned. A few additional contracts have been placed for deliveries extending over the second half of the year, but orders have been chiefly for small parcels for spot or near delivery positions. Delivery specifications from the textile and allied industries in the district are disappointing, but in most other directions fairly steady quantities are being called for. On the whole, chemical prices are on a reasonably stable basis. Buying interest in the tar products is mostly quiet still and in one or two directions values have been shaded.

Price Changes

Falls: Chrometan, liquor; cadmium sulphide; carbolic acid, crude (Manchester); creosote; cresylic acid, pale, 99/100 per cent. (Manchester); naphthalene, purified crystals; magnesium chloride (Glasgow); red lead (Glasgow).

GLASGOW.—Business in chemicals has been rather quieter during the week, both for home trade and export. Prices generally continue very steady at about previous figures, with no actual changes to report, though lead and copper products are inclined to be rather firmer, on account of the higher prices for the metals.

General Chemicals

ACETONE.—**£45 to £47 per ton.**

ACETIC ACID.—Tech, 80%, £30 5s. per ton; pure 80%, £32 5s.; tech., 40%, £15 12s. 6d. to £18 12s. 6d.; tech., 60%, £22 10s. to £25 10s. MANCHESTER: 80%, commercial, £30 5s.; tech. glacial, £42 to £46.

ALUM.—Loose lump, £8 7s. 6d. per ton d/d; GLASGOW: Ground, £10 7s. 6d. per ton; lump, £9 17s. 6d.

ALUMINIUM SULPHATE.—£7 2s. 6d. per ton d/d Lancs. GLASGOW: £7 to £8 ex store.

AMMONIA, ANHYDROUS.—Spot, 1s. to 1s. 1d. per lb. d/d in cylinders. SCOTLAND: 10½d. to 1s. 0½d., containers extra and returnable.

AMMONIA, LIQUID.—SCOTLAND: 80°, 2½d. to 3d. per lb., d/d.

AMMONIUM CARBONATE.—£20 per ton d/d in 5 cwt. casks.

AMMONIUM CHLORIDE.—Grey galvanising, £19 per ton, ex wharf.

AMMONIUM CHLORIDE (MURIATE).—SCOTLAND: British dog tooth crystals, £32 to £35 per ton carriage paid according to quantity. (See also Salammoniac.)

AMMONIUM DICHROMATE.—8½d. per lb. d/d U.K.

ANTIMONY OXIDE.—£68 per ton.

ARSENIC.—Continental material £11 per ton c.i.f., U.K. ports; Cornish White, £12 5s. to £12 10s. per ton f.o.r., mines, according to quantity. MANCHESTER: White powdered Cornish, £16 10s. per ton, ex store.

BARIUM CHLORIDE.—£11 10s. to £12 10s. per ton in casks ex store. GLASGOW: £11 10s. per ton.

BLEACHING POWDER.—Spot, 35/37%, £9 5s. per ton in casks, special terms for contracts. SCOTLAND: £9 per ton net ex store.

BORAX COMMERCIAL.—Granulated, £16 per ton; crystal, £17; powdered, £17 10s.; extra finely powdered, £18 10s., packed in 1-cwt. bags, carriage paid home to buyers' premises within the United Kingdom in 1-ton lots. GLASGOW: Granulated, £16, crystal, £17; powdered, £17 10s. per ton in 1-cwt. bags, carriage paid.

BORIC ACID.—Commercial granulated, £28 10s. per ton; crystal, £29 10s.; powdered, £30 10s.; extra finely powdered, £32 10s. in 1-cwt. bags, carriage paid home to buyers' premises within the United Kingdom in 1-ton lots. GLASGOW: Crystals, £29 10s.; powdered, £30 10s. 1-cwt. bags in 1-ton lots.

CALCIUM BISULPHITE.—£6 10s. per ton f.o.r. London.

CHARCOAL, LUMP.—£6 to £6 10s. per ton, ex wharf. Granulated, £7 to £9 per ton according to grade and locality.

CHLORINE, LIQUID.—£18 15s. per ton, seller's tank wagons, carriage paid to buyer's sidings; £19 5s. per ton, d/d in 16/17 cwt. drums (3-drum lots); £19 10s. per ton d/d in 10-cwt. drums (4-drum lots); 3½d. per lb. d/d station in 70-lb. cylinders (1-ton lots).

CHROMETAN.—Crystals, 2¾d. per lb.; liquor, £9 10s. per ton d/d station in drums. GLASGOW: 70/75% solid, £5 15s. per ton net ex store.

CHROMIC ACID.—10d. per lb., less 2½%; d/d U.K.

CHROMIUM OXIDE.—11d. per lb.; d/d U.K.

CITRIC ACID.—1s. 0½d. per lb. MANCHESTER: 1s. 0½d. SCOTLAND: B.P. crystals, 1s. 0½d. per lb.; less 5%, ex store.

COPPER SULPHATE.—£21 7s. 6d. per ton, less 2% in casks. MANCHESTER: £17 15s. per ton f.o.b. SCOTLAND: £18 per ton, less 5%, Liverpool, in casks.

CREAM OF TARTAR.—100%, 92s. per cwt., less 2½%. GLASGOW: 99%, £4 12s. per cwt. in 5-cwt. casks.

FORMALDEHYDE.—£20-£22 per ton.

FORMIC ACID.—85%, in carboys, ton lots, £42 to £47 per ton.

GLYCERINE.—Chemically pure, double distilled, 1.260 s.g., in tins, £4 2s. 6d. to £5 2s. 6d. per cwt. according to quantity; in drums, £3 15s. 0d. to £4 7s. 6d.

HYDROCHLORIC ACID.—Spot, 5s. 6d. to 8s. carboy d/d according to purity, strength and locality.

IODINE.—Resublimed B.P., 6s. 4d. per lb. in 7 lb. lots.

LACTIC ACID.—(Not less than ton lots). Dark tech., 50% by vol., £24 10s. per ton; 50% by weight, £28 10s.; 80% by weight, £50; pale tech., 50% by vol., £28; 50% by weight, £33; 80% by weight, £55; edible, 50%, by vol., £41. One-ton lots ex works, barrels free.

LEAD ACETATE.—LONDON: White, £31 10s. ton lots; brown, £35. GLASGOW: White crystals, £30; brown, £1 per ton less. MANCHESTER: White, £30; brown, £29.

LEAD, NITRATE.—£32 per ton for 1-ton lots.

LEAD, RED.—£30 15s. 0d. 10 cwt. to 1 ton, less 2½% carriage paid. SCOTLAND: £30 per ton, less 2½% carriage paid for 2-ton lots.

LITHARGE.—SCOTLAND: Ground, £30 per ton, less 2½%, carriage paid for 2-ton lots.

MAGNESITE.—SCOTLAND: Ground calcined, £9 per ton, ex store.

MAGNESIUM CHLORIDE.—SCOTLAND: £7 5s. per ton.

MAGNESIUM SULPHATE.—Commercial, £5 10s. per ton, ex wharf.

MERCURY.—Ammoniated B.P. (white precip.), lump, 5s. 10d. per lb.; powder B.P., 6s. 0d.; bichloride B.P. (corros. sub.) 5s. 1d.; powder B.P. 4s. 9d.; chloride B.P. (calomel), 5s. 10d.; red oxide cryst. (red precip.), 6s. 11d.; levig. 6s. 5d.; yellow oxide B.P. 6s. 3d.; persulphate white B.P.C., 6s. 0d.; sulphide black (hyd. sulph. cum sulph. 50%), 5s. 11d. For quantities under 112 lb., 1d. extra; under 28 lb., 5d. extra.

METHYLATED SPIRIT.—61 O.P. industrial, 1s. 5d. to 2s. per gal.; pyridinised industrial, 1s. 7d. to 2s. 2d.; mineralised, 2s. 6d. to 3s. Spirit 64 O.P. is 1d. more in all cases and the range of prices is according to quantities. SCOTLAND: Industrial 64 O.P., 1s. 9d. to 2s. 4d.

NITRIC ACID.—Spot, £25 to £30 per ton according to strength, quantity and destination.

OXALIC ACID.—£48 15s. to £57 10s. per ton, according to packages and position. GLASGOW: £2 9s. per cwt. in casks. MANCHESTER: £49 to £55 per ton ex store.

PARAFFIN WAX.—SCOTLAND: 3¾d. per lb.

POTASH CAUSTIC.—Solid, £35 5s to £40 per ton according to quantity, ex store; broken, £42 per ton. MANCHESTER: £38 10s.

POTASSIUM CHLORATE.—£36 7s. 6d. per ton. GLASGOW: 4¼d. per lb. MANCHESTER: £37 per ton.

POTASSIUM DICHROMATE.—5½d. per lb. carriage paid. SCOTLAND: 5½d. per lb., net, carriage paid.

POTASSIUM IODIDE.—B.P. 5s. 6d per lb. in 7 lb. lots.

POTASSIUM NITRATE.—Small granular crystals, £24 to £27 per ton ex store, according to quantity. GLASGOW: Refined granulated, £29 per ton c.i.f. U.K. ports. Spot, £30 per ton ex store.

POTASSIUM PERMANGANATE.—LONDON: 9¾d. per lb. SCOTLAND: B.P. Crystals, 9¾d. MANCHESTER: B.P. 10¾d. to 1s.

POTASSIUM PRUSSIATE.—6½d. per lb. SCOTLAND: 7d. net, in casks, ex store. MANCHESTER: Yellow, 6¼d. to 6½d.

PRUSSIATE OF POTASH CRYSTALS.—In casks, 6¾d. per lb. net, ex store.

SALAMMONIAC.—Firsts lump, spot, £42 17s. 6d. per ton, d/d address in barrels. Dog-tooth crystals, £36 per ton; fine white crystals, £18 per ton, in casks, ex store. GLASGOW: Large crystals, in casks, £37 10s.

SALT CAKE.—Unground, spot, £3 11s. per ton.
SODA ASH.—58% spot, £5 17s. 6d. per ton f.o.r. in bags.
SODA, CAUSTIC.—Solid, 76/77° spot, 13s. 10s. per ton d/d station. SCOTLAND: Powdered 98/99%, £18 10s. in drums, £19 5s. in casks, Solid 76/77° £15 12s. 6d. in drums; 70/73%, £15 12s. 6d., carriage paid buyer's station, minimum 4-ton lots; contracts, 10s. per ton less.
SODA CRYSTALS.—Spot, £5 to £5 5s. per ton d/d station or ex depot in 2-cwt. bags.
SODIUM ACETATE.—£19-£20 per ton carriage paid North. GLASGOW: £18 10s. per ton net ex store.
SODIUM BICARBONATE.—Refined spot, £10 15s. per ton d/d station in bags. GLASGOW: £13 5s. per ton in 1 cwt. kegs, £11 5s. per ton in 2-cwt. bags. MANCHESTER: £10 10s.
SODIUM BISULPHITE POWDER.—60/62%, £20 per ton d/d 1 cwt. iron drums for home trade.
SODIUM CARBONATE MONOHYDRATE.—£20 per ton d/d in minimum ton lots in 2 cwt. free bags.
SODIUM CHLORATE.—£27 10s. to £32 per ton. GLASGOW: £1 11s. per cwt., minimum 3 cwt. lots.
SODIUM DICHROMATE.—Crystals cake and powder 4½d. per lb. net d/d U.K. with rebates for contracts. MANCHESTER:
SODIUM CHROMATE.—4½d. per lb. d/d U.K.
4d. per lb. GLASGOW: 4¼d. net, carriage paid.
SODIUM HYPOSULPHITE.—Pea crystals, £15 5s. per ton for 2-ton lots; commercial, £11 5s. per ton. MANCHESTER: Commercial, £11; photographic, £15 10s.
SODIUM METASILICATE.—£14 5s. per ton, d/d U.K. in cwt. bags.
SODIUM NITRATE.—Refined, £8 per ton for 6-ton lots d/d. GLASGOW: £1 12s. 0d. per cwt. in 1-cwt kegs, net, ex store.
SODIUM NITRITE.—£18 5s. per ton for ton lots.
SODIUM PERBORATE.—10%, 9½d. per lb. d/d in 1-cwt. drums.
SODIUM PHOSPHATE.—Di-sodium, £12 per ton delivered for ton lots. Tri-sodium, £15 to £16 per ton delivered per ton lots.
SODIUM PRUSSIATE.—4½d. per lb. for ton lots. GLASGOW: 5d. to 5¾d. ex store. MANCHESTER: 4¼d. to 5¼d.
SODIUM SILICATE.—£8 2s. 6d. per ton.
SODIUM SULPHATE (GLAUBER SALTS).—£3 per ton d/d.
SODIUM SULPHATE (SALT CAKE).—Unground spot, £3 to £3 10s. per ton d/d station in bulk. SCOTLAND: Ground quality, £3 5s. per ton d/d. MANCHESTER: £3 12s. 6d.
SODIUM SULPHIDE.—Solid 60/62%, Spot, £11 15s. per ton d/d in drums; crystals, 30/32%, £9 per ton d/d in casks. MANCHESTER: Concentrated solid, 60/62%, £11; commercial, £8 10s.
SODIUM SULPHITE.—Pea crystals, spot, £14 10s. per ton d/d station in kegs.
SULPHUR PRECIP.—B.P., £55 to £60 per ton according to quantity. Commercial, £50 to £55.
SULPHURIC ACID.—168° Tw., £4 11s. to £5 1s. per ton; 140° Tw., arsenic-free, £3 to £3 10s.; 140° Tw., arsenious, £2 10s.
TARTARIC ACID.—1s. 1¼d. per lb. less 5%, carriage paid for lots of 5 cwt. and upwards. MANCHESTER: 1s. 1¼d. to 1s. 1½d. per lb. GLASGOW: 1s. 1d. per lb., 5%, ex store.
ZINC SULPHATE.—Tech., £11 10s. f.o.r., in 2 cwt. bags.

Rubber Chemicals

ANTIMONY SULPHIDE.—Golden, 7d. to 1s. 2d. per lb., according to quality. Crimson, 1s. 6d. to 1s. 7½d. per lb.
ARSENIC SULPHIDE.—Yellow, 1s. 5d. to 1s. 7d. per lb.
BARYTES.—£6 to £6 10s. per ton, according to quality.
CADMIUM SULPHIDE.—4s. to 4s. 3d. per lb.
CARBON BLACK.—3¼d. to 3 15/16d. per lb., ex store.
CARBON DISULPHIDE.—£31 to £33 per ton, according to quantity, drums extra.
CARBON TETRACHLORIDE.—£41 to £46 per ton, according to quantity, drums extra.
CHROMIUM OXIDE.—Green, 10½d. to 11d. per lb.
DIPHENYLGUANIDINE.—2s. 2d. per lb.
INDIA-RUBBER SUBSTITUTES.—White, 4¾d. to 5¼d. per lb.; dark 3¾d. to 4¼d. per lb.
LAMP BLACK.—£24 to £26 per ton del., according to quantity. Vegetable black, £35 per ton upwards.
LEAD HYPOSULPHITE.—9d. per lb.
LITHOPONE.—Spot, 30%, £16 10s. per ton, 2-ton lots d/d in bags.
SULPHUR.—£9 to £9 5s. per ton. SULPHUR PRECIP. B.P., £55 to £60 per ton. SULPHUR PRECIP. COMM., £50 to £55 per ton.
SULPHUR CHLORIDE.—5d. to 7d. per lb., according to quantity.
VERMILION.—Pale, or deep, 4s. 9d. per lb., 1-cwt. lots.
ZINC SULPHIDE.—£58 to £60 per ton in casks ex store, smaller quantities up to 1s. per lb.

Nitrogen Fertilisers

AMMONIUM SULPHATE.—The following prices have been announced for neutral quality basis 20.6% nitrogen, in 6-ton lots delivered farmer's nearest station up to June 30, 1938: November, £7 8s.; December, £7 9s. 6d.; January, 1938, £7 11s.; February, £7 12s. 6d.; March/June, £7 14s.
CALCIUM CYANAMIDE.—The following prices are for delivery in 5-ton lots, carriage paid to any railway station in Great Britain up to June 30, 1938: November, £7 10s.; December, £7 11s. 3d.; January, 1938, £7 12s. 6d.; February, £7 13s. 9d.; March, £7 15s.; April/June, £7 16s. 3d.
NITRO CHALK.—£7 10s. 6d. per ton up to June 30, 1938.
SODIUM NITRATE.—£8 per ton for delivery up to June 30, 1938.
CONCENTRATED COMPLETE FERTILISERS.—£11 4s. to £11 13s. per ton in 6-ton lots to farmer's nearest station.
AMMONIUM PHOSPHATE FERTILISERS.—£10 19s. 6d. to £14 16s. 6d. per ton in 6-ton lots to farmer's nearest station.

Coal Tar Products

BENZOL.—At works, crude, 9½d. to 10d. per gal.; standard motor, 1s. 3d. to 1s. 3½d.; 90%, 1s. 4d. to 1s. 4½d.; pure, 1s. 8d. to 1s. 8½d. GLASGOW: Crude, 10d. to 10½d. per gal.; motor, 1s. 4d. to 1s. 4½d. MANCHESTER: Pure, 1s. 7d. to 1s. 8d. per gal.; crude, 11d. to 1s. per gal.
CARBOLIC ACID.—Crystals, 7¾d. to 8½d. per lb., small quantities would be dearer; Crude, 60's, 2s. 9d. to 3s.; dehydrated, 3s. to 3s. 3d. per gal. MANCHESTER: Crystals, 7¼d. per lb. f.o.b. in drums; crude, 2s. 3d. per gal.
CREOSOTE.—Home trade, 5d. to 5¼d. per gal., f.o.r. makers' works; exports, 6¾d. to 6¾d. per gal., according to grade MANCHESTER: 4¾d. to 5¼d. GLASGOW: B.S.I. Specification, 6d. to 6¼d. per gal.; washed oil, 5d. to 5½d.; lower sp. gr oils, 5¾d. to 6¼d.
CRESYLIC ACID.—97/99%, 2s. to 2s. 3d.; 99/100%, 3s. 6d. to 5s. 6d. per gal., according to specification; Pale, 99/100%, 2s. 4d. to 2s. 7d.; Dark, 95%, 1s. 8d. to 1s. 10d. per gal. GLASGOW: Pale, 99/100%, 5s. to 5s. 6d. per gal.; pale, 97/99%, 4s. 6d. to 4s. 10d., dark, 97/99%, 4s. 3d. to 4s. 6d.; high boiling acids, 2s. to 2s. 6d. American specification, 3s. 9d. to 4s. MANCHESTER: Pale, 99/100%, 2s. 6d.
NAPHTHA.—Solvent, 90/160, 1s. 6d. to 1s. 7d. per gal.; solvent, 95/160%, 1s. 7d. to 1s. 8d., naked at works; heavy 90/190%, 1s. 1d. to 1s. 3d. per gal., naked at works, according to quantity. GLASGOW: Crude, 6¾d. to 7¼d. per gal.; 90%, 160, 1s. 5d. to 1s. 6d., 90%, 190, 1s. 1d. to 1s. 3d.
NAPHTHALENE.—Crude, whizzed or hot pressed, £5 5s. to £6 5s. per ton; purified crystals, £11 10s. per ton in 2-cwt. bags. LONDON: Fire lighter quality, £5 to £6 per ton. GLASGOW: Fire lighter, crude, £6 to £7 per ton (bags free). MANCHESTER: Refined, £15 per ton f.o.b.
PITCH.—Medium, soft, 33s. per ton, f.o.b. MANCHESTER: 32s. 6d. f.o.b., East Coast. GLASGOW: f.o.b. Glasgow, 35s. to 37s. per ton; in bulk for home trade, 35s.
PYRIDINE.—90/140%, 13s. 6d. to 15s. per gal.; 90/160%, 10s. 6d. to 13s. 3d. per gal.; 90/180%, 3s. 3d. to 4s. per gal. f.o.b. GLASGOW: 90% 140, 10s. to 12s per gal.; 90% 160, 9s. to 10s; 90% 180, 2s. 6d. to 3s. MANCHESTER: 10s. to 11s. per gal.
TOLUOL.—90%, 1s. 10d. per gal.; pure, 2s. 2d. GLASGOW: 90%, 120, 1s. 10d. to 2s. 1d. per gal.
XYLOL.—Commercial, 1s. 11d. to 2s. per gal.; pure, 2s. 3d. to 2s. 3½d. GLASGOW: Commercial, 2s. to 2s. 1d. per gal.

Wood Distillation Products

CALCIUM ACETATE.—Brown, £7 5s. to £9 15s. per ton; grey, £9 5s. to £9 15s. MANCHESTER: Brown, £8 10s.; grey, £10.
METHYL ACETONE.—40.50%, £35 to £40 per ton.
WOOD CREOSOTE.—Unrefined, 4d. to 6d. per gal., according to boiling range.
WOOD NAPHTHA, MISCIBLE.—3s. 3d. to 3s. 6d. per gal.; solvent, 3s. 6d. to 3s. 9d. per gal.
WOOD TAR.—£2 to £8 per ton, according to quality.

Intermediates and Dyes

ANILINE OIL.—Spot, 8d. per lb., drums extra, d/d buyer's works.
ANILINE SALTS.—Spot, 8d. per lb. d/d buyer's works, casks free.
BENZIDINE, HCl.—2s. 7½d. per lb., 100% as base, in casks.
BENZOIC ACID, 1914 B.P. (ex toluol).—1s. 11½d. per lb. d/d buyer's works.
m-CRESOL 98/100%.—1s. 8d. to 1s. 9d. per lb. in ton lots.
o-CRESOL 30/31° C.—6¾d. to 7¼d. per lb. in 1-ton lots.
p-CRESOL, 34-5° C.—1s. 7d. to 1s. 8d. per lb. in ton lots.
DICHLORANILINE.—2s. 1¾d. to 2s. 5¾d. per lb.
DIMETHYLANILINE.—Spot, 1s. 7¼d. per lb., package extra.
DINITROBENZENE.—8¼d. per lb.
DINITROCHLORBENZENE, SOLID.—£79 5s. per ton.
DINITROTOLUENE.—48/50° C., 9¼d. per lb.; 66/68° C., 11d.
DIPHENYLAMINE.—Spot, 2s. 2d. per lb., d/d buyer's works.
GAMMA ACID, Spot, 4s. 4¼d. per lb. 100% d/d buyer's works.
H ACID.—Spot, 2s. 7d. per lb.; 100% d/d buyer's works.
NAPHTHIONIC ACID.—1s. 10d. per lb.
β-NAPHTHOL.—£97 per ton; flake, £94 8s. per ton.
α-NAPHTHYLAMINE.—Lumps, 1s. 1d. per lb.
β-NAPHTHYLAMINE.—Spot, 3s. per lb.; d/d buyer's works.
NEVILLE AND WINTHER'S ACID.—Spot, 3s. 3½d. per lb. 100%.
o-NITRANILINE.—4s. 3¾d. per lb.
m-NITRANILINE.—Spot, 2s. 10d. per lb. d/d buyer's works.
p-NITRANILINE.—Spot, 1s. 10d. to 2s. 3¾d. per lb. d/d buyer's works.
NITROBENZENE.—Spot, 4½d. to 5d. per lb., in 90-gal. drums, drums extra. 1-ton lots d/d buyer's works.
NITRONAPHTHALENE.—10½d. per lb.; P.G., 1s. 0¼d. per lb.
SODIUM NAPHTHIONATE.—Spot, 1s. 11d. per lb.; 100% d/d buyer's works.
SULPHANILIC ACID.—Spot, 8¾d. per lb. 100%, d/d buyer's works.
o-TOLUIDINE.—11½d. per lb., in 8/10-cwt. drums, drums extra.
p-TOLUIDINE.—2s. per lb., in casks.
m-XYLIDINE ACETATE.—4s. 8d. per lb., 100%.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

BRITISH FERMENTATION PRODUCTS, LTD., London, S.W. (M., 25/6/38.) June 2, £10,000 debentures; general charge. * £21,560. May 12, 1938.

BROXTOWE, B. AND D. CO., LTD., Old Basford, dyers, bleachers, etc. (M., 25/6/38.) June 13, debenture to Barclays Bank, Ltd., securing all moneys due or to become due to the Bank; general charge. * £2,000. Aug. 9, 1937.

Satisfactions

BROXTOWE, B. AND D. CO., LTD., Old Basford, dyers, bleachers, etc. (M.S., 25/6/38.) Satisfaction June 13, of debenture registered March 24, 1934.

EBBW VALE STEEL, IRON AND COAL CO., LTD., Newport (Mon.).—Satisfaction June 14, of deed registered March 7, 1906.

County Court Judgments

RILEY, EDWIN ANTHONY, R/O, 104 Wigmore Street, W.1. (C.C., 25/6/38.) Chemical refiner (late trading as International Research Laboratories). £14 0s. 5d. May 16.

Company News

Bradford Dyers' Association announce a dividend for the half-year to June 30 on 5 per cent. cumulative preference postponed (paid to December 31, 1932).

United Indigo and Chemical announce dividend at rate of 5 per cent. per annum, subject to tax, for six months ending June 30, 1938, on preference.

Eastwoods Humber Cement announce that interest for half-year ending June 30, less tax, will be paid on 4½ per cent. first mortgage debenture stock to holders registered at that date.

Sudan Salt announce profit for 1937, after N.D.C., staff fund, etc., £15,086; dividend of 3 per cent. (2 per cent.); payment of participation rights of preference shares will amount to £5,076; forward, £2,678.

Sanitas, Ltd., announce that the net profit for the year to March 31, amounts to £82,089; add transfer from reserve not required, £25,000; less tax and N.D.C., £6,853; dividend of 35 per cent. (same); bonus, 30 per cent., tax free (nil); forward, £27,263 (£12,727).

The London Tin Corporation announce that total profits for the year ended April 30 last amounted to £344,083—an increase of £16,700. Dividends on investments rose by £64,422 to £291,781, but profits on realisation were £49,183 lower at £45,111. Tax makes £76,500, against £53,592, and net profits amount to £243,301, compared with £250,519 for the preceding year. The year's dividend is maintained at 7 per cent., less tax, and the carry-forward is sharply up from £83,370 to £143,046.

New Companies Registered

A. P. Moray and Co., Ltd. 340,957.—Private company. Capital, £2,000 in 2,000 shares of £1 each. To carry on business as manufacturers of and dealers in chemicals, gases, drugs, medicines, etc. Subscribers: Amy G. Pitts, 40-43 Chancery Lane, W.C.2; Wm. J. Rand.

T. K. R. Dewe, Ltd. 341,100.—Private company. Capital £500 in 500 shares of £1 each. To carry on the business of consulting, analytical, manufacturing, pharmaceutical and general chemists, etc. Directors: Thomas K. R. Dewe, 87 Mount Road, Hastings; Geo. M. Howard. Registered office: 87 Mount Road, Hastings.

Times Food Products Company, Ltd. 341,305.—Private company. Capital £1,000 in 1,000 shares of £1 each. To carry on business as manufacturers, importers and exporters of and dealers in chemicals, medicines, fertilisers, salts, foodstuffs, oils, etc. Directors: Samuel Davis, 52 Stamford Hill, N.16; Gregory Leot.

Luceyt Products, Ltd. 341,089.—Private company. Capital, £100 in 100 shares of £1 each. To carry on the business of manufacturers of all plastic or colloid products, chemicals, paints, varnishes, colours, etc. Directors: Guy Courtney, Sylvan Mount, Woldingham, Surrey; Paul Courtney, Victor E. Yarsley.

P. C. L., Ltd. 341,263.—Private company. Capital £100 in 100 shares of £1 each. To carry on the business of manufacturers of and dealers in insecticides, disinfectants, chemicals, gases, drugs, etc. Directors: Fdk. W. Lloyd, 12 Alverstone Avenue, East Barnet, Herts.; Chas. Wallis. Registered office: Tudor Works, Abbey Road, Park Royal, N.W.10.

Pedavita Co., Ltd. 341,524.—Private company. Capital £500 in £1 shares (100 founders' and 400 ordinary). To acquire the business carried on as the Pedavita Co., and to carry on business as manufacturers of or dealers in chemicals, etc. Directors: Ernest J. Moore, 24 Lower Sloane Street, S.W.1; Alice Entwistle, Violet L. Moore, Trevor G. Rees. Registered office: 136 Sloane Street, S.W.1.

Calcium Products and Fertilisers, Ltd. 341,616.—Private company. Capital £1,000 in 1,000 shares of £1 each. To carry on the business of quarrying for and producing lime, sand, and similar substances; and to dress, burn and prepare the same for market. Directors: Arnold Jones (managing director), Dolcoed, Pontsarn, Brecknock; David T. Lewis, Thos. Edwards, Mathias S. Thomas.

R. W. P. Pharmacal Products, Ltd. 340,793.—Private company. Capital £100 in 100 shares of £1 each. To carry on the business of merchants, warehousemen, manufacturers agents, manufacturers, wholesalers and retailers of aspirin tablets, essential oils, essences, perfumery, drugs, fine and heavy chemicals, etc. Directors: Robert W. Phillips, 20 Woburn Square, W.C.1; Fredk. R. Wish, Chas. C. Steward.

Castle Chemicals (Hadleigh), Ltd. 341,188.—Private company. Registered June 9. Capital £100 in 100 shares of £1 each. Objects: To carry on the business of manufacturing and analytical chemists and druggists, etc. The permanent directors are: Leslie J. Shearing, 8 Devereux Road, Southend-on-Sea; Francis R. Davidson, "Glentoy," Oakhurst Road, Prittlewell, Essex. Qualification: one share. Registered office: The Avenue, Hadleigh, Essex.

Perma Products, Ltd. 341,377.—Private company. Capital £3,000 in 3,000 shares of £1 each. To carry on the business of manufacturers of and dealers in chemicasl, gases, drugs, plasters, gypsum disinfectants, fertilisers, salts, acids, oils, isinglass, colours, glues, gums, pigments, varnishes, etc. Subscribers: Albert Fletcher, 23 College Hill, E.C.4; Joseph C. Cowles, 23 College Hill, E.C.4. Registered office: 23 College Hill, Cannon Street, E.C.4.

Cutrilin, Ltd. 341,137.—Private company. Registered June 8. Capital, £1,000 in 1,000 shares of £1 each. Objects: To carry on the business of manufacturers of and dealers in chemicals, drugs, pharmaceutical products, insecticides, etc. The subscribers (each with one share) are: Israel Benenson, 49-51 Bedford Row, W.C.1, solicitor; Mrs. Fanny Freedman, 24 Olive Road, Cricklewood, N.W.2. The first directors are to be appointed by the subscribers. Solicitors: Benson and Co., 49-51 Bedford Row, W.C.1. Registered office: 49-51 Bedford Row, W.C.1.

Chemical Trade Inquiries

The following trade inquiries are abstracted from the "Board of Trade Journal." Names and addresses may be obtained from the Department of Overseas Trade (Development and Intelligence), 35 Old Queen Street, London, S.W.1 (quote reference number).

Cyprus.—A well-established firm of importers and agents at Larnaca wishes to obtain the representation, on a commission and purchasing basis, of United Kingdom manufacturers of cement and chemical manures for Cyprus. (Ref. No. 433.)

Palestine.—A firm in Tel-Aviv wishes to obtain the representation, on a commission basis, of United Kingdom manufacturers of perfumery and cosmetics. (Ref. No. 436.)

South Africa.—H.M. Trade Commissioner at Johannesburg reports that the Public Works Department is calling for tenders, to be presented in Pretoria by July 7, 1938, for the supply of one 30 in. motor-driven hydro extractor. (Ref. T.Y. 23187/38.)

France.—An agent established at Montmorency, Seine-et-Oise, wishes to obtain the representation, on a commission basis, of United Kingdom manufacturers of chemical and pharmaceutical products for France. (Ref. No. 444.)

France.—An agent established at Rhône wishes to obtain the representation, on a commission basis, of United Kingdom manufacturers of dyes, powdered pigments for water and cellulose colours, diastatic products and chemicals used in the textile, tanning, and felt hat industries for France. (Ref. No. 445.)

Metallurgical Section

January 1, 1938

Metallurgical Methods in Czecho-Slovakia

BECAUSE of the growing demand for aluminium in Czechoslovakia various plans are being discussed for the establishment of a home industry to produce the metal. There are, however, only very small deposits of bauxite, and supplies of this raw material would have to be obtained from Yugoslavia and France. Nevertheless, Czechoslovakia possesses large deposits of clay at Carlsbad and Znojmo and also alunite at Berehovo in Ruthenia. The alunite deposits are estimated to contain about 40,000,000 tons of recoverable ore, which assays 37 per cent. alumina. At present, it is contemplated to produce potash, alum and potash fertilisers from the alunite, but the Eisenbahn Gesellschaft der Ferdinands Nordbahn may ultimately construct an aluminium-reduction plant near some source of cheap electric power. It has already entered into negotiations with various large hydroelectric power companies operating in Slovakia. Negotiations were recently completed for the annual purchase of 9,000 tons of aluminium from Yugoslavia.

After about six years of idleness, operations are to be resumed at the copper mines at Krompachy, Slovakia, belonging to the Krompachy Joint Stock Copper Co. The new equipment for the production of electrolytic copper was purchased from Austria, and the electrolytic plant will have an annual capacity of 10,000 tons of copper. Plants are also being constructed for the production of sulphuric acid, copper sulphate and sulphur. Although some of the veins assay over 30 per cent. copper, the ore will average only 2.5 per cent. By-products from the electrolytic plant will include small quantities of bismuth, gold and silver. Hitherto only small quantities of copper have been produced in Czechoslovakia, chiefly as a by-product in processing gold, silver-lead, and zinc ores. During the first half of 1937, 16,500 tons of copper were imported, a considerable proportion coming from Britain.

Anglo-American Steel Plans

RICHARD THOMAS AND CO., the well-known steel and tinplate manufacturers, have completed certain arrangements with the American Rolling Mill Co., of Middletown, Ohio, to purchase from them, as from July 5, 1938, all the shares issued by Armco, Ltd., a company which is incorporated in England but at present controlled by the American Rolling Mill Co. The business carried on by Armco, Ltd., was established in England about fifteen years ago, and a large connection has been built up. The brand name, "Armco," will now be available for products produced by Richard Thomas and Co. at their own works, and sold exclusively through Armco, Ltd., which will continue to trade as previously. In addition to selling their interest in Armco, Ltd., to Richard Thomas and Co., the American Rolling Mill Co. have also entered into a contract which places the fullest possible benefits of their American research department at the disposal of Richard Thomas and Co., who are also given the right to send members of their organisation for training in the American works, as well as the right to manufacture all grades of steel made by the American company's patent and secret processes. Moreover, as experts from the American company are to be lent to Richard Thomas and Co., whenever it may be desirable, two important businesses on either side of the Atlantic will be brought into very close association.

Estimation of Cobalt in Steels

A NEW method for the rapid estimation of cobalt in steel (E. Jaboulay, *Revue de Métallurgie*, 1937, *34*, 166) may eventually take the place of the usual method which is based on precipitation with α-nitroso-β-naphthol, because it is quicker and is claimed to give more reliable results. The new method consists in titrating the cobalt solution with standard solutions of potassium cyanide and silver nitrate. The steel (0.5 gm.) is dissolved in hydrochloric acid (1 : 1), oxidised with nitric acid and any tungsten is filtered off. The filtrate is diluted to 200 c.c., cooled, and exactly 40 c.c. of cyanide solution (4.5 gm. per litre) is added, followed by 2N sodium hydroxide solution until the iron hydroxide which is precipitated just redissolves. On diluting to 300 c.c. the iron is again precipitated and a little more sodium hydroxide solution is then added until the iron precipitate coagulates on shaking. A further 20 c.c. of sodium hydroxide is added and the solution diluted to 500 c.c. exactly. The iron hydroxide is then filtered off and 250 c.c. of the filtrate is retained. The excess of cyanide in this solution is estimated by titration with silver nitrate in the presence of potassium iodide, and the percentage cobalt is then calculated. A correction must be applied for any nickel which is present.

X-Ray Methods and Metallurgy

IN the course of his presidential address to the Royal Society on the occasion of the 275th anniversary meeting in London recently, Sir William Bragg made reference to research in the metallurgical field. He pointed out that a cursory glance over the work described in present-day scientific publications showed that remarkable interest was concentrated on magnitudes that were too small to be examined in detail under the microscope and yet too large to be studied conveniently by X-ray methods. The X-ray methods determined with accuracy the details of the crystal structure of iron and its alloys, but this information was insufficient for a prediction of the behaviour of a specimen of steel.

A considerable change in the use of materials for construction had come about in recent years, and the so-called "creep" of materials was now one of the most important matters to the engineer. Its new

importance was due to two causes. First, the development of machinery had necessitated more perfect fitting and less allowance for clearance than was at one time the case, as in modern turbines and internal combustion engines, and in such fine adjustments a creep of one part in one thousand was a serious matter. Secondly, the working temperatures had been greatly increased, and creep was thereby encouraged. There was no doubt that in any specimen but a perfect crystal, changes took place continuously, said Sir William. Every portion of a solid was a liquid for a fraction of its time, and the atoms in that portion were capable of a movement that was restricted and guided by the stabilising action of their surroundings. The constitution of the solid body was now being examined as never before. It was found to possess a grain-like structure, which was not only of interest from the purely scientific point of view, but of fundamental importance to all the constructive work of industry.

Absorption of Light by Thin Films

INTERESTING observations upon the reflection and absorption of light by partially transparent films of silver and aluminium have been recorded by A. Baxter, of the University of Aberdeen (*J. Scientific Instruments*, 1937, *14*, 303), coefficients having been measured for normal incidence upon films prepared by the evaporation of the metals in vacuo. While aluminium films are stable and fairly grey at all densities, silver films show marked colour selectivity which varied with density and with age. The plate glass slip on to which the metal was evaporated was purposely placed at an acute angle to the direction of evaporation so that the resulting film of metal would be graduated in density. Examined over a period of three weeks, to allow oxidation or recrystallisation to take place, the aluminium films showed no change, but the silver films altered colour to a notable degree. Curves plotted from subsequent measurements showed that aluminium behaves in much the same way for all colours of light; this, however, was not true for silver. The deep blue of the denser silver deposit changed to rosy pink at a density of about 0.3. When the films were freshly prepared these colours were very pure, but they became more grey after a lapse of time. It is concluded that aluminium gives a higher reflection coefficient and lower absorption coefficient than silver for blue light; also for green light, except when the reflection coefficient lies between 50 and 75 per cent. For red light aluminium gives better reflection and lower absorption for reflection coefficients below 55 per cent. and silver gives greater values for higher densities.

Recovery of Finely Divided Gold

THE notable increase which has occurred in the monetary value of gold during the last seven years has had considerable influence upon the technical aspects of gold mining and milling operations for recovering the metal. Investigations which have been carried out on Canadian ores to throw light upon the relationship which exists between gold in macroscopic, microscopic, and sub-microscopic particles, has now received publication (*Canadian Mining and Metallurgical Bulletin*, August, 1937).

M. H. Haycock, the author of the original paper prepared for the Canadian Institute of Mining and Metallurgy, shows that the average grain analysis for fifty different ores indicates that about 75 per cent. of the gold values occur within the microscopic range (100 to 0.1 microns), and that the proportion of gold which is present in sub-microscopic sizes (below 0.1 microns) is very small. Hitherto the boundary between amalgamation and cyanidation has generally been considered to be in the vicinity of 200 mesh (74 microns), although in certain favourable cases satisfactory amalgamation has been obtained in sizes well below this figure. From a study of the present laboratory milling results, Haycock gives the lower limit of effective amalgamation, as being between 20 and 37 microns, and the lower limit for cyanidation as 2 to 9 microns, according to the manner of the occurrence of the gold. It is stated that the recovery of gold below the lower size range for cyanidation presents certain difficulties. In the majority of the ores which were examined, the inaccessible gold was contained within dense grains of pyrite or arsenical pyrite. Physical exposure by grinding is incomplete, even in multiple-stage close-circuit grinding, but the batch grinding of flotation concentrates may be successful in cases where the amount of gold-bearing sulphides is small. The alternative of roasting is often cheaper and more effective in exposing the gold, although dust losses and volatilisation may be serious.

Lead in Nickel Plating Baths

FOLLOWING observations on variations in nickel deposits believed to be due to the presence of dissolved lead in the electrolyte, a systematic study of the solubility of lead and of the properties of the deposits produced from the lead-containing solutions has been made and reported by Raub and Wittum (*Korrosion und Metallschutz*, 1937, *13*, 261). Baths of six different compositions were investigated, and for each bath the hydrogen ion concentration and the temperature of operation were varied over a wide range. The lead was introduced into the bath as lead chloride or as metallic lead, and further experiments were made using lead anodes in nickel plating baths of varying composition.

In the course of these investigations it was found that the effect of lead anodes, vat linings, etc., varies according to the composition of the bath. In baths in which no chlorides are present an adherent protective film is formed on the lead. At low current densities this film consists of lead sulphate, but with rising current density it is gradually changed to lead peroxide. In baths containing chloride the lead was severely attacked and a large amount of loosely adherent lead peroxide was formed, with the result that heavy sliming of the bath took place. The presence of ammonium salts and of citrates had an inhibiting effect on the formation of lead peroxide slime. Although the chemical solubility of lead is only slight in most types of nickel-plating solution, it may be fairly considerable in citrate baths, but the extent to which the lead is dissolved is dependent on the temperature and the hydrogen ion concentration of the solution.

Baths containing a high proportion of chlorides attack lead, but the effect is considerable only at raised temperature. In the citrate baths, on the other hand, solubility falls with rise in temperature.

Difference of Orientation of Two Crystals*

Influence on the Mechanical Effect of their Boundary

By

BRUCE CHALMERS, B.Sc., Ph.D.

THE influence of the crystal boundaries on the mechanical properties of metals has long been recognised, and various theories have been advanced regarding the structure of the boundary region between adjacent crystals. Since in general the lattices of two neighbouring crystals growing from independently formed nuclei will not register, there must be some modification of the lattices where they join. The two principal theories as to the nature of this modification are (*a*) that a structureless or amorphous layer of a thickness of at least some tens of atoms occupies the space between crystals, and (*b*) that the atoms are arranged on a transitional lattice joining one crystal to another.

There are two ways of distinguishing between these theories. In the first place, the amorphous theory regards the atoms of the boundary layer as being disposed at random, whereas the transitional theory considers each atom as having a calculable position; and secondly, the structure and properties of the amorphous layer should be independent of the relative orientations of the axes of the bounding crystals, while a transitional lattice should vary in its structure and properties according to the angle through which the transition is made.

That the second of these criteria can be applied has already been indicated by the author (Chalmers, 1937). A number of specimens of tin of cylindrical form, some consisting of a few crystals with longitudinal boundaries, were subjected to tensile tests, and the results showed that the different behaviours of different specimens could only be accounted for by the hypothesis that the effect of a crystal boundary depends on the difference of orientation of the crystals.

In the experiments to be described cylindrical specimens consisting of two crystals, separated by a longitudinal boundary, were subjected to a simple tensile test. The crystals were orientated similarly with respect to the axis of the cylindrical specimen, so that rotation through an angle A about this axis of the specimen would bring one into coincidence with the other. This ensures that the resolved shear stresses on all equivalent planes, and hence necessarily on equivalent glide planes, were the same with a given load in all experiments. Everything thus being fixed except the angle A, which varied from specimen to specimen, the variation of critical stress with A was investigated, the meaning attached to critical stress being defined in the paper. The results are discussed in terms of the boundary structure.

Preparation of "Bicrystal" Specimens

The experimental work consisted in (*a*) preparing cylindrical specimens of tin, each specimen consisting of two crystals with a longitudinal boundary, (*b*) determining the orientation of the two crystals of each specimen, and (*c*) applying a tensile test to determine the characteristic stress for each specimen. The specimens were all made from the same ingot of "Chempur" tin (analysis, tin 99.98 per cent., copper 0.00132 per cent., antimony 0.00118 per cent., lead 0.00585 per cent., iron 0.00055 per cent., bismuth 0.00352 per cent., arsenic 0.00005 per cent., nickel 0.00003 per cent., silver 0.00018 per cent., zinc, cobalt and sulphur, nil) by the following method.

Glass tubes of internal diameter 3.5 mm. were filled with tin for a length of 10-15 cm. by suction from a crucible containing molten tin, and the specimens prepared by a modification of the "moving furnace" method (Andrade and Roscoe 1937) in which the specimen tube is fixed horizontally and a heating coil is moved slowly along, melting the specimen locally so that it refreezes progressively from one end. The introduction of two seed crystals of smaller diameter and of the required orientations into the tube at the end from which crystallisation starts, so that the ends of the seeds are melted when in contact with the molten end of the specimen, causes crystallisation to commence with two orientations, the lattices meeting at a boundary which is roughly a diameter of the cross-section. If the rates of crystal growth of both parts are equal, then the crystals extend along the whole specimen in such a way that the boundary between them is a plane containing the axis of the cylinder.

To ensure that the crystal lattices are all similarly orientated with respect to the axis of the specimen, not only for the two crystals comprising one specimen, but from specimen to specimen, the following orientation of all the seeds was adopted. The 001 axis was arranged to be perpendicular, and the 101 axis to be at 45°, to the axis of the specimen. This symmetry about the axis ensures that the resolved shear stress shall be the same on corresponding planes in different cases, but leaves the angle a between the 001 axis of the two crystals constituting a given specimen under control.

The angle A was adjusted to any desired value by manipulating the seed crystals so that their 001 axes were at the required angle before they were brought into contact with the molten meniscus from which crystallisation of the specimen started. When the orientations of the two seeds with respect to the specimen axis are different, then in general the boundary is not a diametrical plane but becomes a plane inclined to the specimen axis. This is receiving further investigation. A single seed instead of two was used when it was required to prepare a single crystal of the same orientation.

Measurement of Orientation

The optical reflection method previously described (Chalmers, 1935) was used for the determination of the orientations. The specimen, after etching with ferric chloride solution, was mounted on the axis of a goniometer, and a beam of slightly converging light directed radially on to it. The reflection spots were viewed on a screen, and the positions of the goniometer circle were observed at which the 001 spot of each crystal was at a given position on the screen. The difference of the two angles gave the angle between the 001 axes of the two crystals. The identification of the 001 spot was carried out by using the method detailed in the paper to which reference has been made (Chalmers, 1935).

By means of preliminary experiments it was found that a very simple tensile test would serve to determine a characteristic property of each specimen. An extensometer was constructed in which a load could be applied in units of 50 g. with a leverage of 5, and for a gauge length of 2 cm. the extension was measured with a magnification of about 250 by means of an optical lever.

As the load is increased from zero, no extension is observed until the stress reaches a value characteristic of the specimen, after which the extension continues rapidly if the stress is further increased. In order to estimate rather more accurately the minimum stress that causes a measurable extension, a definite value (0.2 mm. on the scale) was chosen as defining the minimum observable extension, and a curve was plotted of extension and load, the load being applied at a fixed rate. A typical curve is shown in Fig. 1. Interpolation between A and B indicates the load that would produce the extension indicated by CD. No claim for great accuracy is made for this method of determining the standard

* *Proc. Roy. Soc.*, 1937, A.*162*, 120.

stress, but it is probably accurate to ±20 g., which is shown by the results to be adequate for the present purpose. Since the specimens were all prepared in glass tubes of the same size, the stress can be taken as proportional to the load applied.

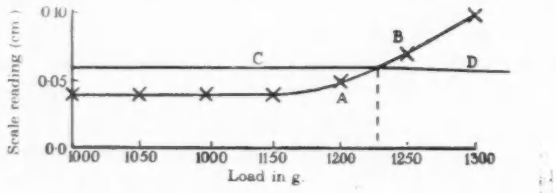

Fig. 1.

Reference to the results obtained with a precision extensometer on a similar specimen prepared accidentally in an investigation on single crystals shows that microplasticity does not occur with such specimens (Chalmers, 1936), and that the flow increases very rapidly when the critical stress has been exceeded; hence the values obtained here are slightly greater than, but related to, the minimum stresses that cause flow to occur.

Experimental Results

The experimental results can best be exhibited in the form of a graph, Fig. 2, relating the angle A between the 001 axes of the two crystals, with the load required to produce the minimum observable extension. It will be observed that the points fall roughly on a straight line and the point for zero angle (*ie.*, a single crystal) is on the same line. Further, it has been found that the direction of the boundary plane with respect to the axes has no influence on the mechanical property under consideration, different specimens with the same angle A but different positions of the boundary giving the same results within the limits imposed by the experimental method.

Before discussing the implications of the results described

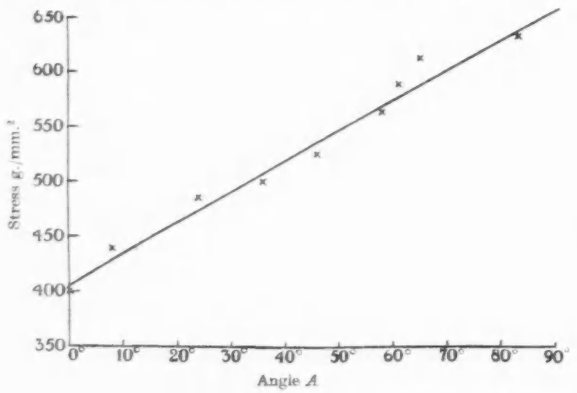

Fig. 2.

above it may be useful to consider certain features of the experimental procedure. It will have been observed that the crystal boundary concerned is always longitudinal, and therefore parallel to the direction of application of stress. The boundary is effective over the whole gauge length but is not solely responsible for any part of the extension. The effect of the boundary may be (*a*) to introduce a thin layer having mechanical properties of its own, differing from those of the crystals, and (*b*) to modify the stress-strain properties of the crystals.

This method of preparation of the specimens, *i.e.*, direction of crystallisation parallel to the boundary, should ensure that the boundary resembles that formed in the usual way in a perfectly pure metal, *i.e.*, should be free from the impurities segregated by eutectic solidification. Application of mercury shows that preferential diffusion takes place along this kind of boundary as it does along ordinary ones (Chalmers, 1937, p. 298), showing that the diffusion of mercury does not depend on the presence of eutectic impurities. Another feature of the experimental technique is that every crystal was similarly oriented with respect to the stress, and so under a given stress all the specimens would stretch by the same amount if it were not for the effect of the boundaries. The experiments deal, therefore, with the effect of the boundary in modifying the stress-strain relations of the crystals, and with the mechanical properties of the boundary layer itself. The results show that the critical stress as defined above varies from the value for a single crystal for $A = 0°$ to a maximum for $A = 90°$, the greatest possible angle.

The effect of the boundary, considered as superimposed on a single crystal, varies from zero at $A = 0°$ to a maximum for $A = 90°$, the variation being approximately linear. On account of the lack of precision in the determination of the critical load, however, too much significance must not be attached to the actual form of the curve obtained in Fig. 2. A linear relationship between load and angle is unlikely to be a true representation of the effect, and it is hoped that more refined measurements will reveal the function of the angle with which the load varies linearly.

Distortion at the Boundary

It follows that if the boundary structure is independent of A, as the amorphous theory requires, the boundary itself makes no contribution to the mechanical property under test and the change is entirely due to the effect of the two lattices on each other, tending to prevent extension for a large angle A more than for a small angle. Since the two crystals should stretch equally, there is no reason why each should tend to prevent the other extending

The possible lateral distortion at the boundary that may accompany glide would vary according to the direction of the boundary relatively to the crystal axes, and since the direction of the boundary has been found to be of no significance it follows that the mutual prevention of this lateral distortion cannot be the cause of the change of mechanical properties with the angle A. In any case, if the boundary were symmetrically disposed between the axes of the two crystals the lateral distortion should be the same for both crystal faces at the boundary, which should then not hinder glide for large angles A more than for small ones. The same criticism also applies to the adsorbed layer theory, which is therefore also rendered untenable.

On the other hand, if the boundary is regarded as a transition zone between one lattice and the other, the hindrance to glide of each lattice may be controlled by the amount of transition between the two lattices, a violent transition (A large) being more effective in preventing glide than a slight transition (A small), which is in agreement with the experimental results.

A modification of the transitional lattice theory (Hargreaves and Hills, 1929) suggests that two lattices may share some atoms if the inclination of the lattices happens to have certain values deduced from geometrical considerations; such a theory is not supported by the present experiments, as it should give small stresses for certain intermediate angles between 0° and 90°, which were not observed.

It would seem that the result obtained for tin is probably of general application, since the behaviour of tin under stress is very similar to that of other metals at temperatures similarly related to the melting-point, so the conclusion is that the effect of crystal boundaries in determining the mechanical properties of a crystal aggregate depends entirely on the angles between the axes of neighbouring crystals, and that this constitutes strong evidence for the transitional lattice boundary theory.

Summary

The effect of the boundary between the crystallites in a metal specimen on the mechanical behaviour is of fundamental importance for the understanding of the strength of

polycrystalline metals. The present investigation deals with a particularly simple case, in which the effect of a single boundary can be measured. The specimens tested consist of two crystals with a longitudinal boundary prepared so that the orientation of the lattices of the two crystals with respect to the direction of the stress is the same in all cases, while the angle between the two lattices varies from specimen to specimen. The results show that the critical tension varies regularly with the angle between the two crystals, being a minimum when the two lattices are similarly orientated (*i.e.*, for single crystals) and a maximum when the two lattices are at right angles. It is concluded that the boundary has no inherent strength, and that the results are best explained as the effect of a transitional lattice. The evidence is against the existence of an "amorphous layer" or "intercrystalline cement."

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Galvanised Wire Manufacture

Joint Recovery and Deposition of Zinc

IN 1933 the Bethlehem Steel Co., in the United States, erected at Sparrow Point works an electrolytic plant for recovering zinc from its ores and then electrolytically depositing the zinc on iron and steel wires. A larger plant of the same kind was subsequently erected at Johnstown works, and reference was made to it in THE CHEMICAL AGE, July 4, 1936, Metallurgical Section, p. 2. These plants jointly are concerned in galvanising 90 tons of wire daily by the electrolytic process.

According to *Mechanical Engineering* (U.S.A.), roasted zinc ore, or ore concentrate, containing 68-70 per cent. zinc, is treated with a sulphuric acid solution to dissolve the zinc oxide. The acid thus used is regenerated for further use in the electrolytic cells. Insoluble iron, silica, and lead are removed from the solution by filtration, and copper, cadmium, nickel, and cobalt are precipitated by adding zinc dust to the solution, which in displacing the named impurities, is itself dissolved. The solution is now a nearly pure solution of zinc sulphate.

For the electrolytic deposition of the zinc on the steel wire, the current density required is 10 to 20 times as high as that for producing cathode zinc according to the Kellog electrolytic zinc process; the time during which the wire is retained in the bath ranges from one to several minutes, according to the thickness of zinc coating required on the wire. The process is continuous, and the time during which the wire is retained in the bath is regulated by the rate of travel of the wire through the bath. As soon as the coated wire leaves the bath, it is passed through rings which act to increase the density of the zinc coating and also to make the coating smooth and polished. The product is a bright smooth wire ready for the market.

It is now generally known that it is possible to produce zinc electrolytically at a purity of 99.995 per cent., and it has been found that wire coated with a zinc of this purity is a superior product to that coated with 99.9 per cent. zinc. The higher degree of flexibility of this nearly pure zinc gives to the covered surface—iron or steel wire, or steel plate—an increased resistance to cracking and scaling-off of the protective surface.

The new process is characterised by the fact that the zinc is electrically deposited in a strong and uniform coating consisting of 99.995 per cent. pure zinc, and that the zinc is obtained directly from concentrated zinc ore, thus avoiding the necessity of dissolving plate zinc to make the electrolytic bath. Experience has shown that the usual acid pickling process for the removal of grease, salts, and crusts on the surface of the wire, is not sufficiently active to effect a complete cleansing of the wire and to result in a galvanised product of the best properties. This difficulty has been overcome by passing the wire through a bath of molten caustic soda, which provides a perfectly prepared surface to receive the zinc coating.

Some Recent Metallurgical Patents

Refining Lead Alloys

Sodium is added to molten impure lead or lead alloys, containing copper, arsenic, tin and one or more of antimony, bismuth and noble metals, but no zinc, the copper, arsenic and tin being conjointly removed as a floating crust. By using excess of sodium, part or all of the antimony may be removed. Sodium may be added as such or as an alloy, other than a sodium-zinc alloy, and excess may be removed by treatment with steam or water. Practically pure lead-antimony alloy may be obtained. (See Specification 465,345, of Soc. Miniere and Metallurgique de Penarroya).

Selenium Additions to Copper

Selenium is added to copper or copper alloys for the purpose of improving machinability. The amount of selenium may be 0.01-4 per cent., preferably 0.25-1 per cent. Other elements may be present of such nature and in such quantity as not to cause separation of the selenium from the molten alloy, for example one or more of the following in specified proportions or ranges of proportions: nickel, zinc, tin, silicon, manganese, iron, aluminium, and cadmium. The presence of antimony, silver, phosphorus, magnesium, calcium, and zirconium is also referred to. (See Specification 466,675, of G. G. Barker).

Refining Aluminium

Magnesium is removed from aluminium alloys containing magnesium by treating the alloys with reagents adapted to form magnesium chloride or fluoride at temperatures above the melting point of such salts, for example chlorine, aluminium chlorides or fluorides, or cryolite. Chlorine may be used at about 950-1,000° C. Other halides such as silicon tetrachloride or cupric chloride may be used whereby the magnesium is replaced by silicon or copper with the formation of aluminium-silicon and aluminium-copper alloys. (See Specification 469,593, of I. G. Farbenindustrie).

Coating with Metals

To produce a lead coating free from pin holes on metal, *e.g.*, iron or steel, the metal is cleaned either in an acid bath or in a bath of caustic alkali and then in an acid bath, and is then freed from acid by immersion in a neutralising bath which has a soda base, but is not caustic soda, *e.g.*, a bath of bicarbonate of soda, passed through a cold or cool solution of zinc chloride, the strength of which does not exceed 90° Twaddell and the temperature of which does not exceed 70° F., and passed into a bath of molten lead through a flux consisting of ammonium chloride and glycerine. (See Specification 466,849, of R. Garbutt and W. P. Butterfield, Ltd.).

Basic Steel

In the manufacture of basic steel in which the lime required for the dephosphorisation is introduced into the converter in two stages, 92-96 per cent. of the lime in lump form is charged into the converter and on that the molten iron to be treated is charged. The charge is then blown until the phosphorus content of the steel is about 0.15 per cent., the converter turned into a horizontal position and the phosphatic slag is skimmed or scraped off the bath as completely as possible by a wooden scraper so that not more than 3-5 per cent. of the slag remains, the remainder of the lime (8-4 per cent.) in powder form added and the after blow carried out until the lime is slagged. (See Specification 467,378, of Soc. Anon. des Forges et Acieries du Nord et de L'est).

Steel Production

Steel with the characteristics of steel produced in the basic Siemens-Martin furnace is produced in a Thomas converter by subjecting a crude iron, the composition of which is suitable for treatment by the Thomas process, to a normal blowing in a Thomas converter, the temperature of the bath being increased to at least 100° C. above that normally employed by the employment of blast air preheated to 300-700° C., so that the manganese is constantly reduced from the slag and such a manganese content, 0.3-0.7 per cent., attained in the steel that an addition of ferro-manganese as a deoxidiser is unnecessary. To assist the action the lime may be used hot as it comes from the kiln. (See Specification 464,482, of P. Kuhn).

Distilling Magnesium

Before the vaporous and gaseous products are cooled and diluted in the manner specified in the parent Specification, they are cooled to a temperature which is such as to produce a mixture of magnesium, magnesium oxide, and carbon, and after the cooling and dilution the resulting dust is compacted and the magnesium distilled therefrom in an electric resistance furnace. The proportion of magnesium to the other constituents depends upon the exact temperature to which the products are cooled. The mixture is then compacted with hydrocarbon oils, and brought into the form of porous granules by heating to temperatures at which the oils are cracked. The granules are heated by direct resistance heating and the magnesium condensed. In an example, cooling from 1,900° C. to 1,870° C., which may be effected by adjustment of the furnace temperature or by allowing the temperature of the gaseous products to fall gradually, produces an equimolecular mixture of magnesium and carbon and magnesium oxide. (See Specification 469,602, of Oesterreichisch Amerikanische Magnesit Akt.-Ges.).

Refining Magnesium

Magnesium and light alloys containing magnesium are first melted with a thinly fluid non-inspissated flux and when both the metal or alloy and the flux are completely molten, the melt is stirred and an inspissating agent added. The inspissating agent may be added as such or as a flux containing a sufficient proportion of inspissating agent for the latter to have an inspissating effect on the thinly fluid flux. Thereafter, a protective cover of inspissated flux may be applied over the metal or alloy and the latter heated to substantially above pouring temperature, *i.e.*, to above 800° C. The thinly fluid flux may be anhydrous carnallite or mixtures still richer in potassium chloride or anhydrous magnesium chloride with or without additions of chlorides other than potassium chloride and tending to lower the melting point. The inspissation may be effected by mixtures of magnesium chloride with magnesium fluoride, calcium fluoride and/or magnesium oxide or of calcium chloride with magnesium fluoride. The fluxes may be merely mixtures of the ingredients or the ingredients may be preliminarily melted down together and the mass crushed after solidification. The fluxes may also comprise additions which are reduced by the melt to enter the metal or alloy, or, when an alloy is treated, salts of a metal already present in the alloy. (See Specification 469,347, of I. G. Farbenindustrie).

Porous Metal Bodies

Porous metal bodies applicable as filters, moulds, wicks, accumulator plates, and catalysts, are made by moulding powdered metal compounds, preferably oxides, and preferably such as have been highly heated, in admixture with an absorbent material such as charcoal and plasticising additions such as oils, fats, fatty acids, polyvalent alcohols, inorganic solutions such as of alkalies or water glass, or tar distillates, with or without adsorbents such as metal hydroxides, or gas-liberating substances such as ammonium bicarbonate; the mixture is sintered and the metal compounds reduced to metal. The reduction is effected either by the plasticising additions or by the use of carbon monoxide or hydrogen in the furnace chamber. Compounds of a single metal may be used, or mixtures of compounds may be treated to produce porous alloys; and substances such as carbon or silicon, whose presence is required in the pores of the product, may be present in the mixture treated. (See Specification 468,518, of Accumulatoren-Fabrik Akt.-Ges.).

Rust-proofing Metals

A mixture of phosphoric acid and a sulphation product of an alcohol containing six or more carbon atoms is used for rust-removing or rust-proofing. In modifications, salts of the sulphation products may be employed and also products obtained by sulphonating esters of the higher alcohols, or ether-alcohols such as monooctadecyl-, octadecenyl- and hexadecyl-glyceryl ethers. According to examples: (1) a sulphation product of a mixture of stearyl and cetyl alcohols is mixed with a phosphoric acid solution; (2) phosphoric acid is mixed with the sodium salts of the sulphation products of alcohols containing 12 to 18 carbon atoms. The compositions are sufficiently viscous to be applied to vertical steel panels. Oleyl, lauryl, carnaubyl, melissyl, myristyl, linoleyl and ricinoleyl alcohols are mentioned and also chlorinated and other halogenated alcohols. Lithium, magnesium, pyridine, piperidine, cyclohexylamine, alkylcyclohexylamine, mono-, di- and tri-alkylamine and alkylolamine salts of the sulphonated alcohols may be used. (See Specification 467,839, of Grasselli Chemical Co.).

Structure of Metal Coatings

Electrodeposited and Hot-dipped Coatings Compared

ELECTRODEPOSITION and hot-dipping are largely used methods of applying protective coatings to steel and other metals. The choice of the method to be used is influenced not only by manufacturing considerations, but also by the use to which the coated article is to be put, for the two types of coating electrodeposited and hot-dipped, vary very much in their behaviour when subjected to deformation, corrosion and other causes of wear. There has been a good deal of work done to ascertain the fundamental differences between the two types of coatings and this work, and some original contributions to it, are reviewed in Technical Publication, Series A, No. 67 of the International Tin Research and Development Council.

The microscope, X-ray and electron-diffusion have been instrumental in elucidating what is at present known regarding the structure of coatings. It is only in recent years that the technique for examining the cross-section of a coating of metal has been developed. It is also pointed out that hot-dipped metals may be regarded as extremely thin chill-castings adhering to the basis metal and a view of the microstructure of the surface is not necessarily any indication of the underlying structure. Examination of the cross-section of thin layers shows the crystal structures to be very different according to the conditions of their formation. The reasons for the differences which occur in the case of tin and of zinc are discussed. When subjected to deformation zinc coatings break sharply while tin stretches in a ductile manner as shown in a number of photomicrographs. The effect of co-deposited matter in producing boundary embrittlement is also discussed.

Metallurgical Section

February 5, 1938

Current Topics

A Record British Steel Output

STATISTICS which have recently become available indicate that the British steel industry is now so well equipped that it is actually producing steel at a yearly rate which is far in excess of production during any previous year. For 1937 the production of steel ingots and castings reached a record figure of nearly 13 million tons (out of a world production, according to "The Iron and Coal Trades Review" of 130 million tons), an increase of considerably more than one million tons over 1936 and more than five million tons over 1935. This notable increase has been made possible because the process of scrapping and reconstructing the older steel-making plant in Britain, and of extending large-scale integrated works, has proceeded rapidly during the past few years. Since the beginning of 1936, moreover, this reconstruction work has also been accelerated by an increased demand for steel. New furnaces appear to have been put into operation at a speed which has outstepped the supplies of the necessary raw materials for steel-making, and at the end of 1937 the total capacity of the steel furnaces of the country was 13½ million tons per year, whereas at the end of 1936 it was only 12¾ million tons, and about 11 million tons at the end of 1929.

Reconstruction of Steel Works

ACCORDING to the British Iron and Steel Federation it is estimated that the iron and steel industry has spent £20,000,000 in new and reconstructed furnaces, mills and associated equipment, during 1936 and 1937, whereas in 1929 new capital expenditure amounted to only £2,300,000. The reconstruction programme for the industry, however, is not yet complete, and work which is still in progress in South Wales, in the Clydeside area, in Lincolnshire and elsewhere, will possibly involve a further expenditure of over £10,000,000 during the present year. Ultimately, at the end of 1938, the steel-making capacity of the country will have been increased to rather more than fourteen million tons per year. Noteworthy features of the completed reconstruction programme will be a larger output of pig iron with a corresponding capacity for it at the steel works, an increased use of home-produced ores by the basic open-hearth and the basic Bessemer processes, and a large increase in the number of coke ovens in actual operation at the steel-makers' works.

The world production of pig iron, as estimated by the National Group of Iron Producers, at Berlin, increased during 1937 by nearly 13½ million tons to a total of close on 105 million tons; raw steel increased by 12 million tons to just over 136 million tons. Record production figures were reached in Germany, England, Czechoslovakia, Sweden and Soviet Russia; there was also a notable production in Japan and British India.

European Developments

THE Deutsche Edelstahlwerke, of Krefeld, has become Germany's second largest manufacturer of high-grade steel after Friedrich Krupp, being now practically controlled by the Vereinigte Stahlwerke, of Düsseldorf, the outstanding producer of iron, steel, and coal. The production of the Vereingte Stahlwerke for the year ending September, 1937, totalled 6,040,000 tons of pig iron and 6,280,000 tons of ingot steel. The Krupp blooming process makes it possible to smelt iron in the form of blooms by using granulated coke or coal as a reduction agent, and has now become of interest to important iron and steel producers in Japan, who have given an order to the Friedrich Krupp-Grusonwerk, of Magdeburg, for the delivery of eight large iron furnaces adapted to this particular process, with the exclusive right to apply the process in Japan and Manchuria.

In order to secure a just distribution of scrap iron and steel, a special scrap-purchasing office, the Schrollzentrale G.m.b.H., has been organised in Germany at Dusseldorf. It will have the task of allotting the scrap to the various concerns in the Rhineland, Westphalia, and Saar districts on the basis of a special schedule of distribution to be fixed monthly. No profits will be made, the open scrap trade will not be eliminated, and Government regulations in regard to prices will not be affected.

Sponge Iron Production

THE United States continues to be the largest consumer of sponge iron produced by the Höganäs-Billesholm Co., of Höganäs, the only Swedish producer of this metal. Japan and various other countries, however, are attempting to make purchases of sponge iron, but the company is unable to meet the increased demand due to the greater production of steel and soft iron in which sponge iron is used. Despite continually improved methods, it is understood that high production costs have prevented the manufacture of sponge iron in large quantities. By the Sieurin process, the sponge iron is obtained direct from the iron ore with the use of low-grade coal. It contains from 93 to 95 per cent. of iron, 2.5 per cent. mineral matter, 2 to 4 per cent. ogygen, 0.5 per cent. coal, 0.014 per cent. phosphorus, and 0.03 per cent. sulphur. The Höganäs concern began producing sponge iron about 1900, but it was not until 1911 that the first large quantity £3,800 tons) was made. The annual output has since been between 6,000 and 15,000 tons.

Nickel in Industry

OVER 100,000 tons of nickel in various forms were used in industry throughout the world during the first ten months of 1937. This consumption, according to a statement by the president of the International

Nickel Company of Canada, was nearly 25 per cent. more than the amount used during the same period of 1936, following an increase of about 20 per cent. from 1935 to 1936. Total consumption for the twelve months of 1937 is estimated to reach 125,000 tons, or twice that of 1929. It is stated, however, that a revival of the making of armaments has had little effect upon this increased production of nickel, because armaments take less than 8 per cent. of the world's supply of nickel and this percentage shows signs of declining rather than increasing. It was the favourable experience with nickel-steel armour plates during the Spanish-American war of 1897-8 which raised the armament demand for nickel to such an extent that nickel production until 1918 was almost entirely absorbed by armament requirements. The steady spending of huge sums of money upon research into new uses for nickel, however, has now made the nickel industry so completely independent of armament requirements that even a loss of the armament demand would not seriously affect the nickel market.

Proprietary Nickel Alloys

THERE are now well over one thousand proprietary nickel alloys for peace-time industrial uses, and this number is claimed to be steadily increasing month by month. Research into new uses for nickel, nevertheless, has not alone brought about this notable expansion of world consumption. There has also been an economic aspect, in that the price of nickel has been kept stable for many months at a time and has changed only in the direction of definitely stimulating consumption. Although world consumption has increased nearly fivefold since 1932, the price of the metal has been continuously reduced during the last five years and it now stands at £180 per ton, compared with £240 at the end of 1932. Declines in consumption which have come about as a result of a lower rate of industrial activity in some countries have been more than offset by an increased consumption of the metal for new uses. Production in Canada, like consumption throughout the world, has followed an upward course, and nearly 110,000 tons were produced during 1937, compared with the previous maximum production of 85,000 tons during 1936.

Testing Zinc Coatings

THE measurement of the protective value of zinc coatings applied to iron and steel, other than by accelerated corrosion tests, can be carried out by making an examination of certain properties of the coating, namely, average weight, uniformity, structure and porosity. Detailed descriptions of a large number of tests were given by Mr. L. Kenworthy, of the British Non-Ferrous Metals Research Association, in a paper which was read at the last autumn meeting of the Institute of Metals. He showed that methods for determining average weight mostly depend on a direct weighing of the sample before and after the coating has been removed. Other methods make use of the heat developed or the gas evolved during the dissolution of the coating in acid; in the recently developed electrolytic Britton test (*J. Inst. Metals*, *58*, 211), the time taken to remove the coating with a known current density is used.

Chemical methods of dissolution, depending on a time factor for the determination of thickness, are not applicable to coatings partially or entirely composed of alloy layer, because of variation in the rate of dissolution with composition. They are suitable, however, for the measurement of uniformity, as is the case with the copper sulphate (Preece) test which is described in British Standard Specification No. 443 (1932). The electrolytic test, on the other hand, removes the same weight of coating per unit time irrespective of composition. Structure is preferably determined by metallographic examination, and the weight of the component layers of the coating may be measured by the electrolytic test using potential measurements. Several tests are available for porosity, although this property does not assume the same importance for zinc coatings as for coatings which are electro-positive to iron. The requirements of zinc coatings to withstand corrosion vary with the conditions of exposure. In the case of atmospheric attack the life is almost entirely dependent on the total weight of the coating (including alloy layer); for immersed conditions there is evidence that the composition of the coating plays an important part.

Utilisation of Tellurium

FOR many years tellurium was regarded merely as an obnoxious element that afforded incompetent assayers an alibi for erroneous low reports on the gold content of ores. Only within the last ten years have any real commercial applications been discovered. It is now used to increase the heat resistance of rubber, to toughen it, and to improve its ageing qualities; lead, with an almost imperceptible alloy addition of tellurium, may eventually find wide applications in fields where ordinary lead is too weak. Tellurium-treated steel is beginning to show commercial possibilities, so that although much more tellurium is discarded at metal refineries than can be marketed it is still possible that tellurium ultimately will be sought on its own account. This did occur in the United States during the depression, for when copper refineries were idle the Bureau of Mines received many inquiries regarding tellurium bearing ores. With the revival of copper mining, however, the supply of tellurium once more exceeded the demand.

Quantitive Spectroscopic Analysis

INCREASED activity in metallurgical laboratories throughout the country is indicating an extension of quantitative analysis by spectroscopic means. Technique has now been so improved that twenty or thirty determinations of the composition of cast iron may be carried out in as many minutes. In practice a 40,000 volt 300 kilo-cycle spark is passed between two pencils which are cast from the iron which has to be assayed. The resulting spectograph, consisting of vertical black lines of varying density, is duly developed and evaluated by means of a densitometer, where a narrow beam of light is passed through the plate to fall upon a photo-electric cell which is connected with a mirror galvanometer. With corrections for errors due to the varying density of different photographic plates and changes in the light source, the galvanometer readings are converted into a percentage of the element which is being determined, by the use of special charts which have been worked out and checked against actual determinations. By these means silicon, manganese, nickel, chromium, molybdenum and copper can be estimated with an average accuracy of plus or minus 2 to 3 per cent.

New Methods for Producing Chromium, Manganese and Magnesium

Researches by the Metallurgical Division of the Bureau of Mines

RECENT findings regarding a novel process for the treatment of chromite ores by chlorine, followed by the reduction of the chromium chlorides with hydrogen, indicate that pure chromium metal may be produced cheaply, states the annual report of the Metallurgical Division of the United States Bureau of Mines for 1936-37.

Reduction of Chromium Chlorides

The thermodynamic theory of the reduction of chromium chlorides had been worked out previously and means developed for technically producing such chlorides directly and continuously from chromite ores. The possibilities inherent in reduction by such means will be clear from a comparison of approximately 3 per cent. reduction per cycle when hydrogen gas is passed over chromous or chromic chloride at 800° C., as against a few tenths per cent. possible when the same gas is passed over chromium oxide at temperatures of 1,400° to 1,500° C. Thus, gas reduction, which seems logically suited to produce carbon-free chromium, must be regarded as technically unpromising, even if physically and chemically possible when starting from oxide, both from the point of view of construction of suitable apparatus and excessively low chemical efficiency, but definitely within the bounds of technical feasibility when the anhydrous chloride is the starting point.

In view of the theoretical background already attained, the specific problem involved becomes entirely a study of the feasibility of setting up a circulating hydrogen system in which hydrogen of high purity may be maintained in continuous countercurrent contact over chromium chloride, and with provision for removing the product of the reduction, hydrochloric acid gas, without introducing such impurities as water vapour, oxygen, nitrogen, carbon dioxide, or hydrocarbons. Since the gases produced by the reduction of chromium do not build up enough concentration to exceed the reduction equilibria of iron chlorides, the question of materials of construction is not a major problem and certain types of steel are indicated as entirely suitable materials of construction.

Preliminary experiments showed that the cyclical absorption and desorption of hydrochloric acid gas on active carbon between room temperature and 200° to 300° C. served to remove the hydrochloric acid from the hydrogen, and that the carbon would absorb approximately 4 per cent. its weight of HCl gas per cycle before requiring desorption.

After a series of cyclical tests that seemed to confirm the suitability of carbon in such repetitious usage was completed, a continuous reduction system was set up. Preliminary indications are that the reduction rate will be higher than had been expected from the theoretical equilibrium measurements first mentioned, and that certain expected difficulties, such as volatility of the chlorides, were not serious. The maintenance of high gas purity is indicated by this test to be the only major problem involved and may require the development of special methods of testing and analysing the gas for control purposes. Preliminary estimates further hint at the possibility of producing chemically pure chromium at somewhat less than 20 cents per lb.

Electrolytic Manganese

Other recent metallurgical work carried out by the Bureau of Mines relates to the production of electrolytic manganese. It is stated that the continuous electrodeposition of high-purity manganese from a sulphate solution is possible, provided that the manganese lost from solution by deposition is replaced by the addition of a manganese compound soluble in the spent electrolyte. It has already been shown that pure manganous carbonate added to the spent acidic electrolyte will regenerate manganous sulphate. Preparation of pure manganous carbonate from manganese ore is a somewhat laborious procedure and requires the use of reagents that are not easily recoverable. The use of dilute sulphuric acid as the leaching agent is said to be desirable because the spent electrolyte after electrolysis of a manganous sulphate solution is dilute sulphuric acid, and its re-use would lead to a large saving in the cost of reagents. The results of preliminary work, however, indicated the need for a more direct procedure in separating by electrolytic methods metallic manganese from elements associated with it in domestic ores.

Except for occasional deposits of the minerals rhodochrosite (manganous carbonate) and rhodonite (manganous silicate), manganese is found usually as an oxide or hydrated oxide in the quadrivalent stage of oxidation, which is insoluble in dilute sulphuric acid. Like manganous carbonate, manganous oxide reacts readily with sulphuric acid to form manganous sulphate. It has also been shown that manganese dioxide contained in ores could be reduced to manganous oxide by calcining in a reducing atmosphere at 600° C. It is therefore evident that manganous oxide contained in reduced ore can be used instead of manganous carbonate as a raw material for electrolysis, provided the leach solution can be purified before electrolysis.

With funds provided by a co-operative agreement with the Western Minerals Exploration Co., an experimental plant was erected for the production of electrolytic manganese from domestic ores. A wad or bog type manganese ore from a mine was selected for test purposes.

Construction and Operation of Experimental Plant

A rotating kiln-type furnace was erected. The furnace was essentially a 6 in. rotating pipe 16 feet long and sloping $\frac{3}{4}$ in. per ft. The upper 8 ft. was heated externally with an oil burner, and the lower 8 ft. was cooled with a water spray. Ore mixed with bituminous coal was fed into the hot end. The high temperature liberated the volatile constituents of the coal, which, in turn, reduced the manganese in the ore to manganous oxide. The ore was cooled in a reducing atmosphere and removed from the cold end of the furnace. The capacity of the furnace was about 1 ton in 24 hours.

The ore was leached in a 24 gallon oak barrel provided with a stirrer of wood. Enough sulphuric acid was added to the ammonium sulphate solution of 190 grams per litre concentration to obtain a manganous sulphate content of 50 grams per litre, and ore was added to the acid solution until the solution became neutral. Ninety minutes was required for each leaching operation. The leach solution was brought into contact with iron nails for copper removal and to increase the iron content for arsenic removal by subsequent oxidation and precipitation of ferric iron from the solution. The purified solution was filtered and pumped to the cathode feed tank for electrolysis.

The electrolytic cell consisted of eight mild steel cathodes and nine lead anodes separated by storage-battery wood diaphragms. Each cathode had a plating area of 1.68 square feet, and a current density of 40 amperes per square foot at 5 volts was used. The spent electrolyte, which contained 30 grams per litre of sulphuric acid, was used as a leaching agent for additional reduced ore. The solution was again purified and electrolysed. The total of 7 lb. of high-purity manganese was produced. The current efficiency was between 35 and 40 per cent. Because of a definite re-solution tendency, it was necessary to remove and strip the cathodes after 12 to 24 hour plating periods.

The results obtained established the possibility of produc-

ing electrolytic manganese from domestic ore by a direct and regenerative process that would require reagents only to replace leaching and mechanical losses in the circuit, but failed to establish a satisfactory current efficiency and a more desirable 48 hour plating period. This trouble was traced to impurities in the solution, and methods are therefore being developed for additional solution purification.

On the basis of experience gained in operating the small plant, a new plant has been designed and constructed. The objective is to produce electrolytic manganese on a simulated plant scale by using four cathodes of 7.5 square feet plating area each; to increase the current efficiency and plating time by greater purification of the electrolyte; and to reduce the electrode potential from 5 to approximately 4 volts by using canvas bags as diaphragms in place of the wooden storage-battery separator. The control of impurities in the electrolyte during electrodeposition of manganese is of primary importance.

Tentative conclusions regarding impurities were as follows: (1) Arsenic concentration can be reduced to less than 0.00005 gram per litre, copper to less than 0.0005 gram per litre, iron to less than 0.001 gram per litre, and molybdenum to less than 0.00001 gram per litre conveniently and inexpensively; but no conclusions have been reached regarding zinc removal. (2) Phosphorus, as phosphate, is an objectionable impurity; it is removed during leaching as an iron phosphate or as magnesium ammonium phosphate. (3) Impurities such as bismuth, tin, silver, and antimony found in small quantities in fertiliser-grade ammonium sulphate produced as a by-product of western smelter gases, but so far undetected in domestic manganese ores, interfere with electrolysis.

Magnesium from Magnesite Ores

After an intensive study of all the methods for producing metallic magnesium that have been found in the literature, some notable conclusions have been reached at the Bureau of Mines. On the basis of information now available, there are just two methods by which it may be profitable to extract magnesium from magnesite ores—chlorination of technically pure MgO by heating with carbon and chlorine, followed by electrolysis of the fused chloride, and direct electrothermic reduction of calcined magnesite by carbon, the product being purified by redistillation.

Reduction of magnesia by other metals, alloys, or hydrogen is not feasible either for economic or for thermodyamic reasons. Chlorination and electrolysis of the chloride comprise an indirect "oxide" process that is more efficient than any electrolytic method that has been reported. Direct electrolysis of the oxide, dissolved in a fused salt, has not been successful, but may have possibilities. Electrothermic reduction by carbon, however, is the simplest and most logical method for magnesite, and appears to have unique advantages.

For the purpose of studying the electrothermic reduction of magnesia by carbon, an arc furnace was designed and constructed to permit working under reduced pressures. The walls were constructed of granular, dead-burned magnesite bonded with corn syrup and caustic-calcined magnesite; the roof was made of 1½ in. graphite "beams" laid closely and covered with loose magnesite. The electrodes were mounted horizontally so that the arc was centred 3 inches above the bottom of the reaction chamber. In the same horizontal plane as the electrodes, on an axis at 90° from them there were two ports or openings, through one of which a screw feed pushed cylindrical briquettes of MgO-carbon mixture into the reaction zone. The other port lead to a water-cooled pipe connected to a cyclone dust collector and bag filter. Inlets for the cooling hydrogen gas are provided in this water-cooled port.

A short run was made in which 1 kg. of ore-carbon briquettes was fed during a half-hour period. This was done before the refractory was completely degasified to prevent overheating and to obtain information on the behaviour of the reaction. The operation appeared to be smooth and satisfactory. Each intermittent feed of the mixture caused a marked increase in the evolution of gas, and it appeared that the rate of feed did not nearly equal the capacity of the furnace.

After the furnace had cooled, it and the condensing system were opened and inspected. The retort walls and roof were in excellent shape. About one-third of the material fed had not reached the hottest part of the reaction zone and did not react. A considerable portion of the charge had been deposited (by reversal of the reaction) upon the walls of the retort. There was not enough distillate in the condensing system for satisfactory estimation as to quantity. It consisted of MgO and carbon. Failure to obtain metal was not unexpected, because of the short duration of the run, the small amount of hydrogen used, and the large amount of moisture evolved and condensed. Any magnesium that may have condensed as metal would be pyrophoric and quickly oxidised in the presence of moisture or air. Although the condenser was dry at the end of the test, about half a pint of water collected as the furnace cooled. The moisture must have come from the furnace lining, and good results are not possible until it is eliminated.

Apparatus was also designed to study the production of anhydrous magnesium chloride by treating magnesia and carbon with chlorine at elevated temperatures. Chlorine was obtained from an electrolytic home-made cell. Pure MgO, CaO, and various grades of magnesite ores, both raw and calcined, were tested. In most cases a high fraction of the material was converted to anhydrous chloride. Best results were obtained at a temperature just below the melting point of $MgCl_2$, 712° C. The tests have shown that chlorination is not difficult, but this step cannot be used to make a separation of magnesium from calcium. Therefore, to make a satisfactory electrolyte the raw material must be freed from calcium.

A series of roasting and leaching tests was made on crude magnesite in an attempt to produce selective calcination that would result in a mixture of MgO and $CaCO_3$.

In these tests results of considerable interest have been obtained. Between 650° and 700° C., magnesite content of a crude ore can be calcined completely without appreciable changes in the calcite, dolomite, or serpentine. The calcined magnesite crumbles easily and can be separated from the other constituents by classification, wet or dry.

Magnetic Properties of Steel

Work on the magnetic properties of slags has been continued during the past year. Slags from other steel plants have been examined and found to contain a much smaller quantity of iron particles and also to be inherently much less magnetic than the series described in the previous annual report. To carry out the magnetic separation it was necessary to make a simple alteration of the apparatus to handle material of lower magnetic susceptibility. The tendency of the powdered slags to separate into portions of varying susceptibility was less pronounced than in the previous case. As a result of these experiments, it was concluded that the susceptibility of the slag is more sensitive to composition than had been realised; possibly the kind of furnace atmosphere has some effect.

The major activity, however, in connection with the magnetic properties of slags was the development of equipment for determining susceptibility at elevated temperatures. Slags contain a variety of ferrites that are weakly ferromagnetic, and since their Curie temperatures (temperature above which the substance is no longer ferromagnetic) are quite different, it appeared possible that a knowledge of the points at which there was a decrease in susceptibility would aid in identifying the constituents.

A series of slags from an 0.08 per cent. carbon steel was investigated with this apparatus. The first experiments were made by placing the powdered samples in a silica capsule, exhausting the air, and sealing off the connecting tube. The results of these tests show distinct decreases in susceptibility of the sample, which are believed to be caused by a ferromagnetic constituent having passed through its Curie point. The presence of magnetite in some of the samples was indicated by a drop in susceptibility just below 600° C. Iron was obviously present in all the samples where a decrease in susceptibility was observed well above 600° C.

Institute of Metals

New Features of Annual General Meeting

VARIATIONS of the procedure of the past thirty years have been made by the Council of the Institute of Metals in connection with the forthcoming annual general meeting of the Institute, by the new arrangement "official business" is to be divorced from the reading and discussion of papers. The meeting will begin in the evening of Tuesday, March 8, with the presentation of the annual report of Council, the election of the Council for 1938-39, and the delivery of the new president's inaugural address.

The morning and afternoon sessions of the following day, March 9, will be devoted to the presentation and discussion of eight papers. All this portion of the proceedings will be completed between 10 a.m. and 4.30 p.m., instead of covering two days as heretofore. The closing day of the meeting—Thursday, March 10—will have two sessions: a morning one devoted to a general discussion on "The Training and Employment of Metallurgists" (opened by Professor R. S. Hutton, of Cambridge) and an afternoon series of visits to works of metallurgical and engineering interest.

The Institute's annual dinner, on March 9, at 7 p.m., is to be given at a new venue—Grosvenor House, Park Lane—and will be followed by dancing. The meetings will be held at the Institution of Mechanical Engineers as in former years.

Papers to be presented for discussion on Wednesday, March 9, will include:—"The Nickel-Copper-Magnesium Alloys" (W. R. D. Jones and K. J. B. Wolfe). "Alloys of Magnesium. Part VII. The Mechanical Properties of Some Wrought Aluminium-Magnesium and Silver-Aluminium-Magnesium Alloys" (J. L. Haughton and A. E. L. Tate). "Sintered Alloys. I.—Copppr-Nickel-Tungsten Alloys Sintered with a Liquid Phase Present" (G. H. S. Price, C. J. Smithells and S. V. Williams). "The Creep of Tin and Tin Alloys. Part II" (D. Hanson and E. J. Sandford). "The Physical and Mechanical Properties of Nickel-Brasses" (M. Cook).

United States Zinc Industry

Advance Statistical Summary for 1937

IN 1937 the zinc industry of the United States enjoyed its fifth consecutive year of advancement from depression, but much of the rapid gain made in the early months of the year was erased by a severe decline in the final quarter, according to the National Bureau of Mines.

The output of primary metallic zinc from domestic ores in 1937, as reported by producers from figures of actual production for eleven months and estimates for December, was about 550,200 short tons, an increase of 12 per cent. over the 491,803 tons produced in 1936. Production of slab zinc from foreign ores in 1937 amounted to about 6,500 tons, a notable gain over the 329 tons reported for 1936. The domestic primary production was the largest recorded since 1929. Total primary production from domestic and foreign sources in 1937 was also larger than in any other year since 1929.

Of the total output of primary material in 1937, about 117,300 tons were electrolytic zinc. In addition to the primary retort output, about 50,900 tons of redistilled secondary zinc were produced as compared with 42,209 tons in 1936. Thus the total supply of distilled and electrolytic zinc in 1937 was about 607,600 tons, including 195,600 tons of high grade metal.

A total of about 73,000 regular horizontal retorts was reported at the fourteen primary zinc smelters that operated during all or a part of the year. Of that number 48,200 retorts were reported in operation at the end of November, and 47,500 were expected to be in operation at the end of the year. Three plants, one of which also operated horizontal retorts, produced zinc in vertical retorts during the year. At the end of 1936, 40,900 horizontal retorts were reported in operation at primary distillation plants.

Improved Cast Irons

Closer Metallurgical Control in Production

FROM a study of the tendencies during the past few years, it appears that the trend of cast iron production in 1938 will be characterised chiefly by closer metallurgical control in production and by the wider use of alloying elements, states the Electro Metallurgical Co. of New York.

The cast iron foundryman is naturally interested in improving his products while reducing his costs, or at least keeping them within bounds. If, however, he could analyse the molten metal while it is still in the cupola, he could get the right analysis before pouring, and should be able to improve the uniformity and economy of his operations. Some attention has been devoted to the possibility of utilising the spectroscope for the quantitative analysis of the molten metal in the cupola, but practical foundrymen are relying on chill tests with arbitration bars and the general appearance of the fractures to tell whether the desired mechanical properties have been obtained and whether the metal is generally sound. If the metal is too soft and graphitic, this condition can be corrected by the ladle addition of a special ferrochrome. If the metal is too hard, it is softened and improved by the ladle addition of ferrosilicon or of a special graphitiser.

While these forms of control result in uniformly better products, other steps have been taken primarily to increase the efficiency of foundry operations. With many cupolas, fuel has been saved and improved results obtained by increasing the blast pressures. Another advance has been the tendency toward duplexing, in which the cupola is used in combination with other furnaces, such as the electric furnace or air furnace. When most of the scavenging is done in the cupola, and further alloying additions are then made in the secondary furnace, improved recoveries of alloying elements are often obtained. This method also gives thinner slags and improved thermal efficiency in the air furnace. The addition of briquetted ferro-alloys to the air furnace gives excellent results, as the briquettes pass readily through the slag.

Numerous special high-test cast irons will probably be put on the market in 1938. In making these castings, many foundrymen have concluded that an essential step is to employ ferrosilicon briquettes plus low-silicon pig iron rather than high-silicon pig iron alone. The advantages of this procedure are a better recovery of silicon, a finer grained and more uniform structure, and a substantial reduction in the number of rejects. Manufacturers of cast iron pipe are turning more and more to the use of small additions of alloying elements, and they are recommending alloy cast irons instead of carbon steel where resistance to oxidation at ordinary temperatures is important. Low-chromium and chromium-nickel cast irons were first tried out with encouraging results, but recently a 0.35 per cent. chromium, 0.35 per cent. copper type has been receiving favourable attention.

Swedenborg's Treatise on Copper

Publication of a Translation

THE British Non-Ferrous Metals Research Association, in co-operation with the Swedenborg Society, will shortly publish a translation of Swedenborg's famous treatise on copper, "De Cupro," originally published in Latin in 1734. No translation has hitherto appeared.

This book gives an account of the smelting and refining of copper as practised in many countries at the time; the production of brass; the nature of copper ores and their assaying; and various other matters pertaining to the properties of copper, its alloys, and its history. The translation will appear in bound mimeographed form, in three parts, totalling about 550 pages. The publishers wish to bring the translation before the scientific public and others interested at the lowest possible price which will be announced later. On this account the illustrations in the book are not reproduced.

Some Recent Metallurgical Patents

Coating and Colouring Metals

The absorption of dyestuffs into anodic oxide films on aluminium or aluminium alloys is controlled by treating the oxide film with a weak aqueous solution of sodium or potassium mono- or di-hydrogen phosphate either prior to or simultaneously with the treatment with the dyestuff, the phosphate treatment being carried out at a temperature of between about 80° and 100° C. The process is applicable only to those dyestuffs, *e.g.*, Alizarine Red S or Anthracene Blue G.S.R., which can produce substantially permanent colours on aluminium oxide films without the use of a mordant. (See Specification 468,685, of A. N. D. Pullen and British Aluminium Co., Ltd.).

Metal Carbide Alloys

Mixtures of metal carbides are obtained by heating the metals of which the carbides are to be formed in a finely divided condition in admixture with a carburising mixture containing manganese dioxide in a hermetically sealed box. Preferably, the carburising mixture consists of charcoal, manganese dioxide, caustic potash, and ammonium chloride. A temperature of 1,200° C. may be employed, the product being cooled slowly out of contact with air. The metals so treated include ferro-tungsten, ferro-titanium, and ferro-molybdenum. Reference is made to the production of alloys consisting of carbides of iron and tungsten, or carbides of iron, tungsten, and chromium, or carbides of iron and chromium. (See Specification 471,792, of Follsain Syndicate, Ltd., and Sainderichin, X.)

Lead-Antimony Alloys

In a process for separating tin from impure lead-antimony alloys by the addition of an oxidising agent such as litharge to a molten bath of the alloy, the dry dross formed in this way above the bath and containing tin oxide with some lead and antimony, is treated with a slagging agent such as sand or silicious slag whereby the lead and antimony pass to the bath beneath and a liquid slag is formed containing tin oxide. The slag may be purified whilst on the bath by treatment by a reducing agent, such as coal or soft iron, whereby any antimony and lead oxides therein are reduced to metal which passes to the bath beneath. The treatment with an oxidising agent serves to remove zinc and cadmium. In an example, a dross containing 17 per cent. of antimony, 20 per cent. of tin, and the remainder lead and sodium yielded after treatment, an alloy comprising 12 per cent. of antimony, 1 per cent. of tin, and the balance lead. (See Specification 469,519, of A. H. Stevens, American Metal Co., Ltd.).

Extracting Tantalum and Niobium

Ores containing tantalum and niobium or metallurgical bye-products containing such elements in the form of oxide compounds are reduced by means of calcium and aluminium conjointly, with the application of external heat, the tantalum and niobium being completely or substantially completely reduced. The calcium and aluminium may be used in the form of alloys with tantalum and/or niobium. A metal, such as iron, may be added to the charge or reducing bath before, during, or after treatment to obtain an alloy, or the reducing operation may be carried out in a bath of molten metal or alloy; the alloying metal may be added to the charge or bath in oxide form. The slags, residues, or bye-products of the reducing operation may be treated with calcium, and/or aluminium to produce an alloy of tantalum and niobium with calcium and/or aluminium; such alloy may be used as a reducing agent for the primary material. The reduction may be effected in an induction, arc, radiating, crucible, or flame furnace. In an example, an alloy containing 25 per cent. of calcium and 75 per cent. of aluminium is used to reduce a concentrate, iron and fluorspar being added, the resulting alloy containing tantalum, niobium, iron, manganese, silicon, and aluminium. (See Specification 467,482, of W. W. Triggs, Soc. Generale Metallurgique de Hoboken).

Alloy Steels

Alloy steels with a high surface hardness value are produced by incorporating in a steel or alloy steel of low carbon content, in the absence of aluminium, a proportion of tantalum or niobium, *e.g.*, 10 per cent. in excess of that required to absorb the carbon which is capable of being absorbed and then nitrogenising the alloy steel so produced. The steels may also contain elements such as chromium (up to 30 per cent.), tungsten (up to 20 per cent.) and molybdenum (up to 10 per cent). In an example an alloy steel containing up to 0.06 per cent. of carbon and 2.0 per cent. of niobium was nitrogenised at 575° C. (See Specification 469,169, of W. M. Burden, R. Genders and R. Harrison).

Lead and Lead Alloys

Metals are removed from lead alloys by treating the molten alloy with a flux consisting of lead fluoride and lead oxide, which may be in the proportions of a eutectic mixture, with or without lead sulphate. The lead oxide constituent of the flux may be formed in situ by adding to the bath a lead compound such as lead nitrate, or by blowing air into the bath. In carrying out the process, further lead oxide may be added to the flux when it thickens. The spent flux may be regenerated for re-use by reducing part of the contained oxides, or, if the reduction is carried out on the surface of a lead bath, the reduced metals enter the molten bath. The metals removed may include tin, antimony, arsenic, nickel, cadmium, zinc, magnesium, aluminium, alkali metals, and alkaline earth metals. (See Specification 473,642, of Goodlass Wall and Lead Industries, Ltd., and W. T. Butcher).

Gold-Aluminium Alloys

Gold-aluminium alloys of the kind wherein the proportion of gold to aluminium is 78.5 : 21.5 are modified either by increasing the proportion of aluminium to not over 40 per cent. or by wholly or partly replacing such excess by one or more of the metals silver, tin, zinc, cadmium, bismuth, and thallium, or alloys thereof, the constituents of such added alloys preferably being present in their atomic proportions. In making the alloys, the metals should be used in oxide-free form, for example by mechanical removal of the oxide, or by melting under fluorides or in vacuo. The alloys may also be made by heating compressed mixtures of powders of the metals, or by mechanically combining the metals as by doubling and heating, or by causing one or more of the constituents to diffuse into a base of the remainder. The products may be heat-treated for several hours at 200-500° C., preferably in vacuo or in an inert atmosphere. (See Specification 469,290, of Deutsche Gold-und Silver-Scheideanstalt vorm. Roessler).

Magnetic Alloys

Alloys of the iron-nickel-aluminium type for making permanent magnets are made by first melting down all the carbon-containing constituents such as iron, nickel, and cobalt in the absence of aluminium and any other readily oxidisable constituents such as titanium or beryllium, then reducing the carbon content to below 0.1 per cent., *e.g.*, .02 per cent., and then adding the aluminium, etc. Other carbon-free constituents such as copper may be included in the original charge or be added after the oxidisable constituents. The carbon in the original charge is reduced by allowing access to air or by adding certain of the constituents, such as copper, iron, nickel, cobalt, chromium, manganese, and tin, in the form of oxides. A slight excess of aluminium should be added to allow for oxidation. Alloys consisting of (*a*) iron, 7-40 per cent. of nickel, and 3-20 per cent. of aluminium with or without one or more of the following: cobalt, copper, chromium, manganese, tungsten, molybdenum, vanadium, titanium, and (*b*) iron, 22.5 per cent. of nickel, 10 per cent. of aluminium, 13 per cent. of cobalt, 5 per cent. of copper and 0.12 per cent. of carbon, are referred to. (See Specification 471,142, of Bosch Akt.-Ges., R)

Metallurgical Section

March 5, 1938

Current Topics

Thomas Turner Medal Awards

DR. H. W. BROWNSDON, who was presented with the Thomas Turner gold medal for original research work in metallurgy, at a meeting of the University Metallurgical Society at Birmingham, on February 8, has carried out many original investigations—extending back over a period of thirty years—which have been the means of advancing our knowledge of metallurgy and of applying that knowledge in industrial directions. For a large part of his life Dr. Brownsdon has been associated with the research departments of important metallurgical firms, and his work has been notably creditable to the progress of British metallurgy. The Thomas Turner medals were founded to commemorate the services which Professor Turner gave to metallurgy. The gold medal is awarded from time to time to a metallurgist of distinction. The trustees also recognise the work done by students of metallurgy in the technical colleges of Birmingham, and in Birmingham University itself, by the award of bronze medals. This year the Thomas Turner bronze medals have been awarded to W. T. Pell-Walpole, F. A. Ball and S. G. Temple.

Testing the Wear of Metals

WEAR, like friction, is one of the common phenomena about which there is little fundamental knowledge; investigations into the physics of the subject, however, are now steadily attracting increased attention. At the exhibition of physical instruments which was held by the Physical Society, in January, there were two machines of entirely different character for testing the wearing properties of metals. In one case—a commercial machine—consideration had been given to means for minimising certain difficulties which are always encountered in an attempt to measure wear. This particular machine employs a rotating steel ball bearing on a plane surface of the metal under test, with the axis of rotation parallel to the surface; the spherical hollow which was worn in the surface is then measured *in situ* under a microscope as in the Brinell hardness test. The second machine, shown by G. I. Finch and G. L. J. Bailey, of the Imperial College of Science and Technology, had been constructed for use in an investigation by electron diffraction methods into the condition of metal surfaces after receiving various treatments. In this case the degree of wear was estimated by weighing and the flat surface was utilised for examination under the electron camera. Certain important facts have already been established by this new technique and the progress of further work in this direction will receive the close attention of engineers.

Recrystallisation of Pure Nickel

A CRITICAL review of the literature which is available on the recrystallisation of nickel is found to reveal some conflicting statements. The lowest temperature which is graphically evaluated is 530° C. and the lowest temperature found by actual microscopical examination is 550° C. With a view to obtaining more accurate knowledge of this phenomenon of recrystallisation, E. Fetz has recently made a study of the subject using melted carbonyl nickel, pressed carbonyl nickel subjected to inadequate working and annealing treatments, and electrolytic nickel which has been cold rolled from the state in which it was deposited (*Metals and Alloys*, 1937, *8*, 339). The results of this work, in the form of curves and photomicrographs, show that the temperature range of recrystallisation and of the release of hardness after cold-rolling practically coincides in severely-wrought melted carbonyl nickel, compressed carbonyl nickel powder, and electrodeposited nickel. Grain growth, however, differs materially in the various forms of metals. In melted carbonyl nickel recrystallisation was found to commence at 350° C., a temperature which is 200 degrees lower than the lowest recrystallisation temperature of nickel as found microscopically by previous investigators. This discrepancy is attributed primarily to the relative impurity of the nickel which was used in former tests. Revealed microscopically, recrystallisation appears to commence at 350° C. in compressed but insufficiently-worked carbonyl nickel powder (90 per cent. metal). Compressed carbonyl nickel powder cold-rolled 90 per cent. was found to have become partly recrystallised at 200° C. during a period of 100 hours annealing.

Corrosion Resistance of Tantalum

ON account of its excellent resistance to corrosion pure tantalum metal promises to find a good demand in the construction of equipment for use in the chemical laboratory and also industrially in chemical works, where it may replace costly metals (such as platinum) now in use. Steel pipes lined with tantalum are already being used to convey hydrochloric acid; for chlorination, needle valves and nozzles, as well as bleaching tanks, are being made of the metal. The high thermal efficiency of tantalum also makes it useful for the construction of heat exchangers where corrosion may take place and the temperature difference may be as high as 200° C. between the inside and outside of the coils. In another direction tantalum has been employed advantageously for the construction of thermometer wells, because the development of seamless tantalum tubing allows the construction

of wells with heavy walls to withstand a pressure of 200 atmospheres. The application of a surface of tantalum for containers in which corrosive liquids are handled has been extended by the use of an improved welding technique, by which tantalum sheets of a thickness of 1/200 inch can be joined successfully to provide an internal lining for steel vessels. The advantages which accrue from the last named development are realised when it is mentioned that the price of sheet tantalum is about £12 per pound.

Pure tantalum metal was introduced in 1922, and it is now one of the more important rare metals produced on a commercial scale. Its extreme resistance to corrosion by chemical action is one of its striking properties. Hydrochloric, nitric, sulphuric and acetic acids, mixtures of hydrochloric and nitric acids, bromine water, chlorine water and perchloric acid, have no effect in dilute or in concentrated state at either 20° C. or 100° C. Tantalum sheet which is immersed in 30 per cent. caustic potash for 120 days shows no change in weight; sulphur dioxide, and wet and dry chlorine, have no effect below 150° C. Fused alkalis, however, will steadily attack the metal. Seven years after pure tantalum was first available the cost was £30 to £36 per pound; after a lapse of over fifteen years, due to its extended use as a filament wire in electric lamp bulbs, the price has now been reduced to the level of £10 to £12 per pound. If we consider the way in which the use of aluminium has been greatly extended with a notable reduction in price, it is evident that there is also a great future for tantalum if a cheap process can be devised for extraction and production in a usable commercial form.

Plating of Iron Prior to Enamelling

THE methods by which sheet iron surfaces are prepared for enamelling are known to have a marked effect on the adherence of the enamel to the metal surface. Treatments in common use include cold rolling, etching in dilute non-oxidising solutions, etching in dilute oxidising acid solutions, sand blasting, and plating with nickel. A comparative study of the surfaces produced by these treatments, and of the changes taking place during the firing of ground coat enamels, has recently been made by K. Kautz (*J. Amer. Ceramic Soc.*, 1937, *20*, 288). In the case of nickel plating the samples were pickled for four minutes in 6 per cent. sulphuric acid at 71° C. and were then immersed in a boiling solution of nickel ammonium sulphate (16 parts) and boric acid (1 part) in water (640 parts), the pH value being 6/4. Microscopical examination of the treated samples show that coatings on iron which has been given a light plating of nickel have excellent adhesion under most firing conditions, and that the nickel layer if applied compactly and uniformly to the iron surface will retard the rate of oxidation during the scale-forming period. Of the three processes which were found to give satisfactory adhesion, namely, etching with oxidising acid solutions, sand blasting and nickel plating, it was the nickel plating process which appeared to be the most practical method for use at enamelling works. The process is inexpensive and when added to ordinary plant procedure it involves but little additional labour. Temperature control, time of immersion, and regulation of pH are important factors in obtaining the most satisfactory results.

Boron in Nickel Steel

THE influence of boron additions up to 0.1 per cent. on the mechanical properties of cast steel containing nickel has been recorded recently by G. Naton and E. Piwowarsky (*Archiv für das Eisenhüttenwesen*, 1937, *11*, 283). Two carbon steels (0.13 and 0.24 per cent. carbon), and steels of similar carbon contents to which nickel had been added in amounts varying from 1 to 5 per cent., were examined. Mechanical properties and hardness were determined in the quenched, normalised, and quenched and tempered conditions; and in the tempered series the influence of tempering at 50° C., 150° C. and 250° C. and of periods ranging from 1 to 32 hours was studied.

Increasing boron content was found to raise the mechanical strength by varying amounts, the higher tensile strength being accompanied by a marked rise in yield. In the 5 per cent. nickel steel containing boron a specially high yield ratio was obtained. Examination of quenched samples showed that the presence of boron also has a beneficial effect on the ability to harden; elongation and impact, however, were adversely affected. Hardness in the quenched condition was increased to a marked degree; in the case of the 5 per cent. nickel, 0.85 per cent. boron steel, a Brinnel value of 418 was attained, but in spite of the high hardness the steel showed excellent machinability. Tempering at 50° C., 150° C. and 250° C. caused a drop in hardness in all the boron-free steels, but steels containing boron retained the hardness of the quenched state, and the nickel-containing steels showed a slight precipitation-hardening effect. Examination of normalised specimens under the microscope indicated that grain-refinement was produced by boron in the carbon steels and that this was intensified by the presence of nickel.

Research upon Creep in Metals

INTERESTING information upon the creep of metals at high temperatures was given by Dr. R. W. Bailey, of Manchester, when addressing the January meeting of the Midland Metallurgical Societies, at Birmingham. He pointed out that the phenomena of creep had been known for many years and in the case of cast iron it was actually investigated nearly one hundred years ago. It was only during the last twenty years or so that creep had become a matter of considerable importance in connection with power plant operating at high temperatures, and also in connection with certain chemical processes which demanded high temperatures and pressures. At normal temperatures most metals behaved in an elastic manner, but at elevated temperatures—as a result of creep—they underwent a permanent change of dimension. An intensive research of this peculiarity had caused new alloys to come into use and give greater resistance to deformation at high temperatures than did other alloys which were formerly employed. As a result of this it had been made possible to increase the operating temperatures and pressures at power plant to such an extent that there was no parallel in the previous development of prime movers. An examination of the changes associated with creep and structure now enabled the operating life and working conditions of the plant to be predicted with a remarkable degree of accuracy.

Chromium Electrodeposits

Stripping by Chemical Methods for Measurement of Thickness

WORK on the stripping of chromium electrodeposits for thickness measurement, carried out with the aid of funds provided by the British Non-Ferrous Metals Research Association, was described by Mr. S. G. Clarke, Ph.D., A.I.C., in a paper recently read before the Electrodepositors' Technical Society at the Northampton Polytechnic, London.

Chromium coatings present a difficult problem in thickness measurement by other than chemical methods, said Mr. Clarke. The coating, as applied as a tarnishing-resisting finish, is often very thin—of the order of 0.00002 inch—requiring a skilled technique for microscopic measurement of a cross-section, and it is generally below the limit for the Mesle "chord" test. The high resistance to attack by many reagents has prevented the application of the B.N.F. jet test, and thus recourse is necessary to dissolving off the coating in acid or by anodic attack in alkali. The use of acid appeared to be the simpler, and methods based on (*a*) measurement of the time required for solution as shown by the period of gas evolution and (*b*) loss in weight have been investigated.

Measurement from Time of Gassing

Hydrochloric acid at the ordinary temperature dissolves chromium rather slowly, but when some antimony oxide is dissolved in the acid the attack is speeded up. Using hydrochloric acid (sp. gr. 1.16) in which is dissolved 20 g. per litre of antimony oxide (Sb_2O_3), as reagent, the following process appeared feasible for rapid approximate measurement of thickness.

The chromium surface is first rubbed with a wet cloth and fine pumice or magnesium oxide powder, washed in water and dried by wiping with greaseless absorbent paper or cloth (or by acetone treatment); drying need not be thorough. The surface, whole or in part as desired, is immersed in the solution and carefully watched. After a few seconds, a black film spreads over the surface and gassing starts. From this point until gassing stops the time is taken by a stop watch. The temperature of the solution is taken. The thickness of deposit is obtained by simple proportion from the time required to dissolve a unit thickness at the temperature of testing.

If only a black film appears and little or no gas is evolved it is an indication that the chromium is extremely thin, say less than 0.000003 inch. Rubbing the surface before testing with a mild abrasive was found necessary, even when grease was apparently absent. Without this treatment the attack was slow to commence, and occurred in patches, which gradually spread. Cessation of gassing is fairly abrupt with deposits of uniform thickness, but is less clearly defined with many chromium-plated articles owing to a thicker deposit being present on some places, the edges, for example. There is thus a liability to take the period of gassing corresponding with the thicker areas rather than the average thickness. Localising the attack to a selected area by stopping-off the remaining surface with nitrocellulose varnish is advantageous.

Testing Articles without Immersion

An alternative method of testing an article which it is not desired to immerse in the solution is to apply the solution in a ring fixed in close contact with the surface. It has been found convenient to use a glass ring about 1 inch in diameter and 1 inch long provided by the cut off portion of the top part of a large test-tube, the cut surface being ground flat by means of a paste of carborundum and water. The ring is placed on the cleaned chromium surface and a good joint is made by pressing plasticine around the outside. The cup so formed is about three-quarters filled with testing solution. The cessation of gassing is less easy to see than when the surface is dipped in a separate glass vessel, as a mist of bubbles fills the solution and prevents the surface itself being observed. A fair approximation to the right point can be obtained by viewing the liquid sideways through the glass ring. The results tend to be somewhat too high, owing to delay in deciding on the end-point.

For the purpose of standardisation it was necessary to employ deposits having a uniform thickness over the test-area. Small specimens measuring 2 by 1 inch were cut from the middle of a larger sheet of nickel or steel plated on one side only with chromium deposited from a bath containing 250 g. per litre of chromic acid and 2.5 g. per litre of sulphuric acid, worked at 50° C. and at a current density of 200 amp. per sq. ft. Stopping-off the unplated side was done with Detel Red (a suspension of iron oxide in chlorinated rubber dissolved in naphtha), the material being removed after plating by solvent naphtha. The test-specimens were weighed before and after obtaining the time of gassing in the reagent, the loss in weight giving the weight of chromium deposit, from which the thickness was calculated. In order to prevent any interference, the bare nickel side of the specimen was coated with nitrocellulose varnish after the first weighing, the film being removed with acetone prior to the final weighing. During stripping of the chromium, the specimens were supported upright in the reagent.

The values for time of gassing for a thickness of 0.00001 inch of chromium (obtained by dividing the observed time by the known thickness), obtained at several temperatures over the range 12° to 45° C., were plotted and a representative curve was drawn. Temperature was thus shown to have a considerable effect.

Accuracy of Results

Values were generally within 15 per cent. of the thickness found from loss in weight, but occasionally wider differences were found. These may have been due to local variation in thickness of coating on the test-specimen. Variation in current density and temperature of deposition had little effect on the reactivity of the deposit. It appeared that the rate of solution of chromium was not liable to wide variations such as have been found for cadmium deposits prepared under different conditions. The nature of the basis metal had little influence. Separate experiments were carried out to test the effect of contact with exposed basis metal. It was found when employing a chromium plated surface in contact with about twice its area of exposed basis metal (nickel, steel or copper) that the rate of solution was increased by about 25 per cent. In practice, therefore, any bare areas should be first stopped-off by varnishing or else kept above the solution level. When the surface was immersed flat or in a sloping position the rate of solution differed a little from that in the vertical position, the variations being within 10 per cent. The method would thus appear to be applicable to articles of varying shape.

Taking the various factors into account, it was considered that the method could be relied on to give results within about 25 per cent. of the true thickness. This estimate does not include any error which might arise, in testing average thickness, through taking the period of gassing corresponding with the thicker areas on irregularly-plated articles.

Measurement by Loss in Weight

Three methods were tested in which the chromium was dissolved in (*a*) hot dilute sulphuric acid (50 ml. of concentrated sulphuric acid per litre, 65-70° C.), (*b*) cold concentrated hydrochloric acid (at room temperature), (*c*) cold concentrated hydrochloric acid containing 20 g. per litre of antimony oxide. Weighed rectangular pieces of basis metal (nickel, mild steel and copper) were plated with chromium in the ordinary way. As no precautions were taken to ensure uniform thickness, the edges received a considerably thicker deposit than the centre portion. The weighed pieces, rendered clean and grease-free by rubbing with magnesium oxide suspension and afterwards dried, were immersed in the acids, taken out as soon as the action was judged to have ceased, then washed in water, dried

and re-weighed. The average thickness of chromium was calculated from the formula :—

$$\text{Thickness (inch)} = \frac{\text{loss in weight on stripping (gram.)}}{\text{area stripped (sq. inch)} \times 115.}$$

the density of chromium being taken as 7 g./cc. = 115 g./cu. inch.

Hot Dilute Sulphuric Ac²d

The action was slow to commence. Attack could be readily initiated by touching the surface with zinc wire, after which the chromium dissolved by itself with fairly brisk evolution of hydrogen. The thinner centre portion of the coating dissolved away first but the attack continued steadily until all chromium appeared to have gone from the edges. At this point hydrogen evolution entirely ceased with nickel and copper. With steel a slow bubbling continued, but it was fairly easy to decide from the appearance and also from the diminution of hydrogen evolution when stripping was complete. Test results showed that the method was practically quantitative. The attack occurred at about the same rate as in the hydrochloric acid-antimony chloride solution.

Cold Concentrated Hydrochloric Acid

Attack was started by touching the chromium for a few moments with a zinc wire. The solvent action was much slower than with hot dilute sulphuric acid, taking about 4 to 6 times as long for a similar thickness. The thicker edge portions gave the impression of requiring a disproportionately long period for stripping. The results were satisfactory for chromium on nickel and copper. The steel specimen was removed, in order to avoid attack, when the hydrogen evolution had slowed down to a minimum : some chromium then remained on the edges giving a low result for average thickness.

Hydrochloric Acid with Dissolved Antimony

The attack on the chromium took place without the necessity for touching with zinc. When action had ceased the specimen was swabbed with a wet cloth during washing, to remove black powdery antimony, and dried. With the thinner coatings on nickel the accuracy was good, but with the thicker coatings the results tended to be low due to incomplete stripping of the thickest part of the coating at the extreme edges. The residual chromium appeared to have become passive in the solution as gassing had ceased before the specimens were taken out. In a second immersion after weighing, the passive chromium became temporarily active, but did not strip completely. Repeated immersion was not found advisable owing to a tendency for some attack on the basis metals to occur.

The cause of the passivity is not known with certainty. The dull appearance after washing suggested that a protective film of antimony had formed on the residual chromium. Thus it is possible that a reversal of potential of the chromium from anode to cathode occurred when a large area of basis metal had been exposed and all but a small amount of chromium remained. Passivity is only likely to affect a part of the chromium which would be the last to dissolve from the most thickly-coated parts of an article, such as projecting points or extreme edges. In the time of gassing method the passivity effect of the last traces of chromium should thus help to prevent any serious over-estimate of general thickness. With the uniform coatings used in establishing the rate of solution of chromium no sign of non-stripping was shown and there was no reason to deabt the accuracy of the loss-in-weight results.

United States Copper Industry

Improvement in Production, Deliveries and Prices in 1937

THE copper industry in the United States, according to the Bureau of Mines, showed improvement for the year 1937 as a whole in regard to production, deliveries and prices. Following record-breaking demand, falling stocks and rapidly advancing prices late in 1936 and early in 1937, the production rate was advanced sharply. Domestic production overtook domestic deliveries in May and from then until the end of the year producers' stocks of refined copper increased monthly, with the promise of a continuance of this trend into 1938.

The annual figures for 1937 show the following results : smelter production from domestic ores increased 38 per cent. over 1936, refinery new production from domestic sources was 25 per cent. higher and that from foreign sources was 41 per cent. higher than in 1936, reflecting increased importation of crude copper materials. Imports of unmanufactured copper were probably over 40 per cent. above those in 1936 while exports were less than 30 per cent. higher. Quantity increases for both imports and exports, however, were very close so that net exports in 1937 were little different from 1936. Apparent consumption of new copper was 8 per cent. above the previous year. Stocks of refined copper at refineries increased 48 per cent. in 1937 and those of blister copper at smelters, in transit to refineries and of unfinished materials at refineries gained only 19 per cent., so that total inventories of refined and unrefined copper were 29 per cent. larger at the end of 1937 than at the end of 1936.

The smelter production of copper from domestic ores in 1937 as determined from reports of the smelters showing actual production for eleven months and estimated production for December was 1,687,000,000 lb., an increase of 38 per cent. over the output of 1,222,819,396 lb. in 1936. The estimated smelter production from domestic ores for December, as reported by the smelters, was 116,000,000 lb., which is 19 per cent. less than the average reported for the eleven preceding months. The production of new refined copper from domestic sources, determined in the same manner as smelter production, was about 1,614,000,000 lb., compared with 1,290,924,195 lb. in 1936. The output of new refined copper from domestic and foreign sources in 1937 amounted to about 2,113,000,000 lb., compared with 1,644,977,410 lb. in 1936, an increase of 468,000,000 lb. or 28 per cent. The production of secondary copper by primary refineries increased from 265,829,723 lb. in 1936 to about 320,000,000 lb. in 1937. Thus the total primary and secondary output of copper by the refineries in 1937 was 27 per cent. higher than in the preceding year—a production of about 2,433,000,000 lb. being reported for 1937, as compared with 1,910,807,133 lb. in 1936.

Total imports of unmanufactured copper during the first 11 months of 1937 amounted to 502,285,989 lb., compared with 380,677,700 lb. for the entire year 1936, indicating that figures for 12 months of 1937 will probably show an increase of over 40 per cent. more than in 1936.

Exports of metallic copper during the first 11 months of 1937 amounted to 630,207,696 lb., compared with 518,064,333 lb. exported during the entire year 1936. It is likely that the total for the entire year 1937 will be nearly 30 per cent. above that for 1936.

Refineries estimated that at the end of 1937 approximately 325,000,000 lb. of refined copper would be in stock, a 48 per cent. increase from the reserve of 220,000,000 lb. at the end of 1936. It is estimated that stocks of blister copper at the smelters, in transit to refineries and at refineries, and materials in process of refining, would be about 466,000,000 lb. on December 31, compared with 391,000,000 lb. reported on hand at the end of 1936. Total smelter and refinery stocks at the end of 1937, therefore, would be 791,000,000 lb., representing an increase of 180,000,000 lb., or 29 per cent., from stocks at the end of 1936.

Tin Production Statistics

Apparent World Consumption at Record Level

STATISTICS just published by the International Tin Research and Development Council reveal that a series of new records was established in the tin industry in 1937. World production for the year reached a record of 206,900 tons, exceeding production for 1936 by nearly 27,000 tons. World apparent consumption of tin, at 197,300 tons in 1937, was also at record level, and showed an increase of 36,600 tons over the figure for 1936. The estimated consumption of tin in manufacture increased by 8,000 tons to 172,000 tons, the discrepancy between these two computations of consumption indicating that consumers' stocks were appreciably increased during 1937.

Consumption of Various Countries

The apparent consumption of tin in the United States in 1937 was the highest on record at 86,663 tons, showing an increase of nearly 19 per cent. over the figure for 1936. The total quantity of tin shipped to the U.S.S.R. in 1927 was over 25,000 tons, representing about 2½ times the previous year's record of 9,664 tons. Consumption in Japan reached a record of 8,200 tons, while records were also attained in Sweden, 1,909 tons; Holland, 1,470 tons; Denmark, 711 tons; Norway, 595 tons, and Finland, 294 tons. Nearly 26,000 tons were taken by the United Kingdom, where consumption was the highest for ten years. Tin consumption in Germany increased by 37½ per cent. over the 1936 figure to 11,643 tons in 1937, which was the highest figure recorded since 1930.

In several other countries, on the other hand, consumption decreased in 1937; in France there was a decrease of 5.8 per cent., in Italy of 3.7 per cent., and in Poland of 3.8 per cent. The aggregate consumption of all countries which used less than 1,000 tons in 1937 was 13,026 tons, and this figure, which includes the tin consumption of Spain, was 13 per cent. lower than in 1936.

Tin consumption statistics for countries which used more than 1,000 tons in 1937 are tabulated below in comparison with the statistics for 1936:—

	1937 tons.	1936 tons.	Increase or decrease.
United States	85,663	73,039	+ 18.7
United Kingdom	25,971	21,860	+ 18.8
U.S.S.R.	25,125	9,664	+160.0
Germany	11,643	8,462	+ 37.6
France	9,179	9,748	— 5.8
Japan	8,212	6,401	+ 28.3
Italy	3,509	3,642	— 3.7
Canada	2,500	2,164	+ 15.5
British India	2,470	2,293	+ 7.7
Sweden	1,909	1,692	+ 12.8
Czechoslovakia	1,731	1,684	+ 2.8
Belgium	1,520	1,336	+ 13.8
Netherlands	1,470	1,284	+ 14.5
Poland	1,272	1,322	— 3.8
Switzerland	1,100	1 109	— 0.8
Other countries	13,026	15,000	— 13.2
Total apparent consumption	197,300	160,700	+ 22.8

In 1937 new record outputs of tinplate were established in nearly all the important producing countries. About 65,000 tons of tin were used in the manufacture of tinplate in 1937, against 62,000 tons in 1936. Appreciable increases in the consumption of tinplate took place in the United States, the United Kingdom, Germany, Canada and the Netherlands.

The output of tin by the countries signatory to the Tin Control Agreement totalled 179,991 tons in 1937, compared with the permissible exports of 212,474 tons. Of the total under-export of 35,527 tons, only 1,402 tons have been carried forward into 1938. Production by non-signatory countries in 1937 differed only slightly from that of the preceding year. Figures for China are available only up to September, 1937, but these indicate very little change from 1936. Production increased in Burma and in Portugal, but practically no exports of tin-ore from Spain were recorded in 1937.

Some Recent Metallurgical Patents

Alloy Steels

Welding-rods are composed of an alloy steel comprising 2-30 per cent. of chromium, up to 0.5 of carbon, 0.5-2.5 of tungsten or molybdenum or both and niobium in an amount at least 8 times and not over 1.5 per cent. plus ten times the carbon content of the steel. The rod may be used for welding together the adjacent edges of a chromium steel containing 2-30 per cent. of chromium and up to 0.5 per cent. of carbon. (See Specification 475,896 of Electro Metallurgical Co.).

Coating with Metals

Metallic coatings are produced from metals vaporised by an electric arc in a chamber supplied with air or gas under pressure, the vaporised metal being removed through a hollow electrode. The metal to be deposited may itself form one or other of the electrodes or it may be supplied thereto in the form of wire or powder. The materials fused or vaporised may consist of hard metals such as tungsten, zirconium, tantalum, or lighter metals such as aluminium and its alloys, metals such as nickel, chromium, cobalt, iron, or steel and also carbides of metals such as tungsten, chromium, molybdenum, tantalum, titanium, niobium, vanadium, zirconium; silicides, nitrides, or phosphides of hard metals may be used in conjunction with metals fusing at lower temperatures, such as metals of the iron, copper, or zinc groups such as iron, cobalt, nickel, rhodium, copper, zinc, cadmium, antimony and bismuth. (See Specification 473,040 of B. Berg-haus).

Hardening Alloys

In the hardening of magnesium base alloys, especially those containing 7-15 per cent. of aluminium, the cast alloy is subjected to solution treatment, hot-worked at 200-500° C. so as substantially to maintain the solid solution produced and then subjected to a precipitation heat treatment. The solution treatment consists in heating to 280-550° C. for not less than 5 hours which may be followed by quenching, and the precipitation treatment at a temperature of 170° C. for a period of 12 hours. In an example an alloy containing 9 per cent. of aluminium and 0.2 of manganese is heated at 420° C. for 16 hours, cooled in air, heated to 350° C., extruded and then heated at 170° C. for 12 hours. (See Specification 474,812 of High Duty Alloys, Ltd., and R. Jones).

Treatment of Electrodeposited Coatings

Electrodeposited zinc coatings are brightened and passivated by immersion in an aqueous acidic solution of hydrogen peroxide having a *p*H above 0.5 and preferably between 1 and 2.5. The peroxide concentration is between 2 and 8 per cent. H_2O_2 by weight, and the acidifying agent may be sulphuric acid in a proportion by weight of hydrogen peroxide to sulphuric acid within the limits 4:1 and 48:1. Other acidifying materials are hydrochloric, phosphoric, carbonic, acetic, lactic and citric acids, and acid salts such as ferric chloride, potassium persulphate and sodium bisulphate. Before the treatment the coatings may be rinsed in water and dipped in acid. (See Specification 474,977 of Imperial Chemical Industries, Ltd., E. I. Du Pont de Nemours and Co.).

Refining Copper

Bismuth is removed, during the working up of copper mattes to metallic copper by a blowing operation carried out on the molten matte in the presence of silica, by using finely divided silica in excess of that required to slack impurities, such as iron, the presence of free silica being maintained at every stage of the process from the commencement to the end of the blow. The silica may be added in a single charge before blowing on in successive portions, *e.g.*, by blowing in with the blast. Coal or carbon may be mixed with the silica; also a small amount of alkali sulphates or chlorides or lead may be added. Instead of silica, substances containing free silica, silicates which have been opened up with sulphuric acid, ferrosilicon or substances which can form ferrosilicon as an intermediate product may be employed. The resulting blister copper may be further refined with silica; lead may be added to the blister copper, silica and sodium sulphate or chloride or both being then blown in. (See Specification 472,626, of O. Nielsen and E. R. Lauber).

Institute of Metals

First Award of New Medal on March 8

THE Council of the Institute of Metals has found it necessary slightly to modify the programme of the 30th annual general meeting to be held in London on March 8-10. Instead of the first award of the Institute of Metals medal being made at the morning session on March 10, the medal will be presented at the opening session, in the evening of Tuesday, March 8. The proceedings will begin at 7 p.m., and an announcement will be made of a new scheme of co-operation with the Iron and Steel Institute.

On behalf of the Council, the president, Mr. W. R. Barclay, will make the first award of the Institute of Metals medal to Sir William H. Bragg, F.R.S., an honorary member of the Institute. This ceremony will take place at 7.30 p.m. Offered by the Mond Nickel Co., Ltd., for award by the council, this medal—in platinum—is given for outstanding services to non-ferrous metallurgy whether on the practical or scientific side, without restriction of nationality or membership of the Institute.

The new Institute of Metals Medal, to be presented to Sir William Bragg on March 8. The medal, which is of platinum, was offered to the Council of the Institute by the Mond Nickel Co., Ltd.

Following the presentation of the medal, the retiring president will induct into the chair the president-designate, Dr. C. H. Desch, F.R.S., director of the Department of Metallurgy, National Physical Laboratory, Teddington. At 8.15 p.m. Dr. Desch will deliver his presidential address on "A Chemist's View of Metallurgy."

The annual dinner and dance will be held at Grosvenor House, Park Lane, London, on March 9. Acceptances of the council's invitation to be the guests of the Institute at the dinner have been received from the Earl of Dudley, Lord Riverdale, Sir William H. Bragg, and the presidents of many kindred societies.

Invitations to witness the presentation of the medal and delivery of the address can be obtained on application to the Secretary, Institute of Metals, 36 Victoria Street, London, S.W.1.

Letter to the Editor

Lead in Nickel Plating Baths

SIR,—We read with interest your article on "Lead in Nickel Plating Baths" which appeared in the metallurgical section of your issue of January 1. It is interesting to note how the chemical solubility of lead is affected by chlorides and citrates in nickel electrolytes with the variation of current density and temperature.

In view of this information, we would like to acquaint your readers with a remedy that is being generally adopted in the electro-plating industry in this country.

The chemical action on lead in nickel plating baths where the electrolyte is an ordinary sulphate is so small that the efficiency of the bath is barely affected, but where there are chlorides present as in the case with bright nickel plating solution, it is not advisable to use lead at all; but rubber is strongly recommended for bath lining and the various commodities that are used in it.

Rubber is used for most commercial forms of electro-plating, with the exception of chromium, which is a strong oxidising solution and readily decomposes it. Hard rubber (ebonite) and most loaded soft rubber compounds are completely impervious to the chemical and electro-chemical action of nickel sulphate, also sulphates containing citric acid and nickel chloride. Acid resisting rubber and ebonite is as indifferent to current density as it is to temperature fluctuations; nickel plating plants can be completely equipped with this material, even to covering plating racks or jigs, so that no metallic surface other than the electrodes are exposed to the solution.

The process of bright nickel plating is firmly establishing itself in most large plating establishments, but it is still experiencing teething troubles, and quite a lot of this trouble is due to lead tank linings and equipment. In some instances where they have taken the precaution of lining the tank with rubber, the designers have made the fundamental mistake of constructing the air agitation, filtering and circulating systems of lead. After a short period of use, the presence of lead in the solution becomes quite evident and eventually finds its way on to the cathode. There are several manufacturers of bright nickel solutions and consequently the chemical constituents vary to some degree, but the chloride content in most cases is fairly high, the working temperature varies from 80 to 140° F.—Yours faithfully

Nordac Ltd., E. W. MULCAHY.
Dukes Road,
Western Avenue,
London, W.3.

Aluminium Exports from Canada

Increased Consignments to Great Britain

LAST year Japan fell into third place as a purchaser of Canadian aluminium. In 1930 she was Canada's leading export market for the metal and from 1933 to 1936 inclusive she held second place. Great Britain is now Canada's chief customer, absorbing 50 per cent. of Canadian exports; the United States comes second, using 21.7 per cent., and Japan third with 19.5 per cent.

Total exports of aluminium for 1937 reached the record high figure of $17,593,000 for bars, ingots, blocks and sheets, as against a previous high in 1929 of $13,838,000. Out of this total Great Britain absorbed $8,782,000, the United States $3,815,000 and Japan $3,430,000. In 1930 Japan absorbed 33 per cent. of Canadian aluminium exports; she has been purchasing Canadian aluminium since 1921.

An unusual feature of aluminium production in Canada is the fact that practically the only Canadian materials which enter into it are hydro-electric power and labour. Canada's entire production is in the Province of Quebec, where very little of the output is consumed. The other materials required for making it are bauxite from British Guiana, cryolite from Greenland and petroleum coke.

Metallurgical Section

April 2, 1938

Current Topics

University Training for Metallurgists

ONE of the morning sessions at the March meeting of the Institute of Metals was devoted to a discussion of the training and employment of metallurgists. The discussion arose out of a question in the December issue of the *Journal of the Institute of Metals*. Professor R. S. Hutton asked whether the training of future metallurgists was being conducted on the right lines and whether provision was being made for an adequate supply. Professor J. H. Andrews said that there was a tendency to regard a metallurgist as a person concerned with the chemical and physical side of the subject and to disregard the practical application that was necessary when a university man went into industry. Metallurgists should be able to apply their knowledge to works practice, but as a result of the present system of training industry was not getting the type of man it required. A great deal of research now being done was futile; there should be a closer supervision of research to ensure that it would be really useful to industry. These remarks of Professor Andrews were supported by Mr. A. J. G. Smout, of Birmingham, who spoke from the point of view of the industrialist and said little had been done by way of collective thought on the methods of feeding the industrialist with the type of persons required. The quality and quantity of men from the university schools had been such that many industrialists had been obliged to look elsewhere. Dr. W. H. Hatfield, however, disagreed strongly with many of Mr. Smout's opinions. He thought that research papers by young men should be encouraged, even if they might be immature. The universities, on the whole, were producing the right type of men; the test of the well-trained student was the ability to use the knowledge he had acquired at the right time.

The Mechanism of Desulphurisation

THE United States Bureau of Mines has recently directed attention to a more critical study of the mechanism of the desulphurisation of metal by slags. It is stated that the steel manufacturer has been forced to meet more exacting specifications, due to the more rigid requirements demanded of steel by the consumer, and it has therefore become desirable to remove as much of the sulphur as possible in the blastfurnace. The first step in desulphurisation is accepted as being chiefly the result of the interaction of lime and ferrous sulphide whereby (in a reversible reaction) calcium sulphide and ferrous oxide are formed; other bases, such as manganous oxide and magnesium oxide, may react to a lesser degree. In the presence of carbon another reaction also plays a significant part, and the ferrous oxide is reduced to the metallic state with the formation of carbon monoxide. If this latter reversible reaction were allowed to proceed to equilibrium, the ferrous oxide would approach zero and desulphurisation would be substantially complete. Such a condition, however, is never reached in the blastfurnace because ferrous oxide is being replaced continuously in the form of incompletely reduced iron ore and as a result of oxidation in the combustion zone. To determine the effect of the ferrous oxide on desulphurisation, a study of equilibrium in the first mentioned reaction was, therefore, conmmenced. This necessitated the elimination of graphite as a refractory material for holding slag and metal.

After unsuccessful trials with refractory mixtures, a furnace was constructed to utilise a rotating liquid crucible composed of one of the reacting substances. Preliminary values have been obtained for equilibrium at 1,600° C., using purified ferrous sulphide as the liquid crucible to hold the standard calcium-aluminium-silicate slag. Before the equilibrium constants can be evaluated, however, it will be necessary to know the amount of molecular ferrous sulphide present in the slag at different temperatures, or prove that it is substantially insoluble in the slag, but at the present time there is no method for determining the amount of ferrous or manganous sulphide that may exist in blastfurnace slags while desulphurisation is taking place. A study of the absorption spectra of slags containing iron and sulphur has been started and may develop into a method for determining ferrous sulphide in slags. When either ferrous or sulphide or ferrous oxide was added to a slag containing calcium sulphide a highly-coloured brown or black slag was produced; it is thought that the intensity of this colour is proportional to the amount of ferrous sulphide which is present.

Accumulation of Pig Iron Reserves

TOWARDS the middle of last month the Import Duties Advisory Committee had before them an application for the re-imposition of the duties in force before the world scramble for supplies led to the abolition of the duty on pig iron and the reduction to negligible proportions of the tariff on imported steel. It was intimated that the committee did not propose to make any recommendation for the continuation of reduced rates of duty on steel after March 31. Organised opposition to the restoration of the duties did not appear to develop, but a change in the international situation led to suggestions being made that the duty on pig iron should remain in abeyance for a further few months. This view was prompted by the absence of any considerable stocks of pig iron in this country and the enormous value of such reserves should a state of emergency develop. A proposal informally advanced in certain circles was to the effect that the restoration of the duty on imported pig iron should be postponed until substantial stocks had been built up.

Continental pig iron being available in very large tonnages and at comparatively cheap rates the idea, discussed unofficially, was that the Government should consider creating a reserve of at least 250,000 tons of pig iron against possible emergencies. It was said that such a stock could be accumulated with comparative ease under existing conditions without forcing up prices and without disturbing internal trading conditions. British pig iron producers could contribute to a national reserve held by the Government, who, at the same time, could establish an immediate stock by purchasing from the continent a minimum amount of the iron which was now offered freely and cheaply.

A New Steel for High Temperatures

THE high temperature characteristics of a new 1.5 per cent. molybdenum steel in the calorised condition are described by C. L. Clark and R. S. Brown in *Combustion*, Vol. 9, No. 4. The molybdenum provides the strength characteristics and the calorised surface produces a high degree of oxidation and sulphur-corrosion resistance, which are properties advantageous to higher operating temperatures. In the uncalorised state this analysis would possess an oxidation resistance no better than that of a plain carbon steel and in this condition its use would be confined to a maximum operating temperature of 500° to 550° C. When the surfaces are calorised, however, this analysis can be used under properly designed stresses for prolonged service at temperatures up to 650° to 700° C. In general, this new steel has so far been used for tubes, rods and bolts. In one case tubes have been installed in plant for the liquid phase cracking of very heavy cracked residuum oil heated to 550° C., with the unusually high rate of heat input (18,000 B.Th.U. per sq. ft. of surface per hour) which gives high tube wall temperatures. In another case they have been used to heat petroleum vapour under pressure to 760° C. The tubes can be rolled into headers without damage to the calorised interior surface.

Nickel Steels and Cast Irons

THE recently published annual report of the International Nickel Company of Canada makes further reference to low cost nickel alloy steels which are receiving the attention of steel users. These steels offer mechanical properties which are superior to those of plain carbon steels, and prices are lower than those of the standard alloy steels. They are therefore beginning to replace carbon steel in plate and sheet form for many applications where heat-treatment is not required or possible. Many of these steels contain nickel in amounts varying from 0.50 to 1.50 per cent. Their chief usefulness is in structures where weight saving is important, and in many applications where better corrosion-resistance is required than that of plain carbon steel. As a relatively new field for nickel steels, their future appears to be a promising one.

Stimulated by the distribution of information to industrial users throughout the world, the interest in nickel cast iron has also spread to many industrial areas; the most active areas are the United States, Canada and Great Britain. It is estimated that in the United States alone the production of alloy cast iron amounts to from 10 to 15 per cent. of the total volume of iron castings—about 17,000,000 tons in 1937—and of this amount a large proportion contains nickel. Much of this nickel-alloyed iron contains only low percentages of nickel (under 1 per cent.), but a growing proportion comprises those special nickel irons which are highly alloyed and may contain from 5 to 15 per cent. of nickel. The nickel cast iron known as Ni-Resist, in the intermediate corrosion resisting group, possesses good physical properties and moderate corrosion resistance similar to that of bronze and much better than plain cast iron. The hard irons are popular, particularly in the mining, smelting, refining and metal rolling industries.

Refined Antimony of Canadian Origin

THE first commercial production of refined antimony in Canada will take place within the next few months and should have effect in reducing the shortage which has been caused by hostilities in the Far East. The metal will be produced by the Consolidated Mining and Smelting Company of Canada, at Trail, British Columbia, where a new antimony refinery is nearing completion. Small quantities of antimony occur in the silver-cobalt-nickel-arsenic ores which are treated at Deloro, Ontario, and are already shipped abroad for further treatment. Other than this, except for small experimental shipments between 1925 and 1931, there has been no production of antimony in Canada since 1917. The plant at Trail will treat flue dust residues from the company's silver refinery, and is designed to handle 10 tons of these residues daily. Stocked dust will comprise sixty per cent. of the charge until depleted. It is expected that over 1,400 tons of refined antimony will be produced per year. The development is timely, owing to the difficulties that many countries are experiencing in obtaining adequate supplies of antimony from China, which in 1936 supplied 53 per cent. of the total world output of the metal. Another company, incorporated recently in British Columbia, has made arrangements for the production of antimony from gold-antimonal ores.

Removal of Bismuth from Galena

IF bismuth could be removed from galena concentrates and residues before they pass to the lead blast-furnace there would be no necessity for debismuthising the material by other means. No success has apparently been obtained in effecting its complete removal by flotation. Recent investigations in the United States, however, have shown that the leaching of a raw flotation concentrate with ferric chloride in an acidic brine will dissolve 40 to 50 per cent. of the bismuth and only about 10 per cent. of the lead. If the same relative rate of dissolution could be maintained it might be possible to dissolve over 90 per cent. of the bismuth and still less than 20 per cent. of the lead. It would then be possible to precipitate the dissolved bismuth upon lead shot, and thereby recover the lead which has passed into the solution. Unfortunately, however, when it is attempted to prolong the time of treatment it has been found that the rate of dissolving the bismuth decreased and that of the lead increases, so that by the time 70 per cent. of the bismuth is dissolved about 23 or 24 per cent. of the lead will also have passed into solution. With a product containing bismuth associated with copper instead of lead it was found that still less of the bismuth dissolved in acidic brine.

Education of Metallurgists

A General Discussion by Members of the Institute of Metals

THERE was a general discussion on the training and employment of metallurgists, at the final session of the meeting of the Institute of Metals on March 10.

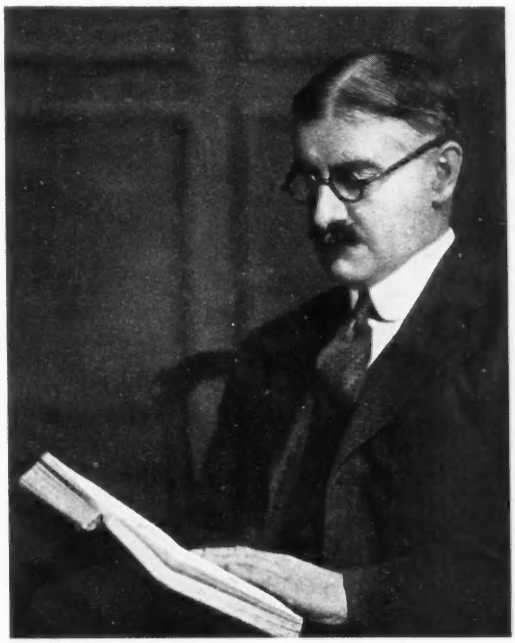
Dr. R. S. HUTTON (professor of metallurgy, Cambridge University) who opened the discussion, and some time ago prepared a paper on the subject for one of the local sections of the Institute, said he had no idea when he did so that it would form the basis of a discussion by a very much wider audience; there were certain things in it which would have been put differently if he had been aware of that. However, the general question was whether those who were to be metallurgists in the future were being trained on the right lines and whether an adequate supply of metallurgists was being planned. Some people seemed to think he had failed to emphasise sufficiently that the majority of metallurgists of to-day had been trained as chemists, and that he had therefore somewhat strong feelings against chemists. In common with the President of the Institute (Mr. W. R. Barclay), Sir Harold Carpenter, and the majority of metallurgists present at the meeting, he started his own career as a chemist, but as he saw the problem now it was not so much to train a few brilliant research men as to plan a general course which would be suitable for a rather wider range of students some of whom might pass directly at the end of the course into industrial occupations.

Adequate Men for Higher Posts

At one time many people thought it might be better to go to a university and study mechanics, physics and chemistry and perhaps not touch metallurgy at all except as a post-graduate subject, but that would not cater for the larger number of men who were precluded for one reason or another from staying long periods at a university. The most provocative part of his paper, said Professor Hutton, was the attempt to show, as far as this country was concerned, the relative importance of the chemical and metallurgical industries, and some figures in this respect were included in the paper. These were taken from the University Grants Committee Reports, but there was a lack of adequate university statistics in this respect throughout the world. Germany was the only country that had gone seriously into this subject, and since the paper was published a book had been published by Dr. Kotsching, but even he on practically every page deplored the lack of reliable data. There was a great need for bringing the industrial employer into touch with the subject, because it was vital to have an adequate supply of man power for the higher posts is the industry.

The PRESIDENT (Mr. W. R. Barclay) said that as one who had taught both chemistry and metallurgy he felt that the number of students given in the paper as taking the two subjects were rather misleading. The reason for the very large number of students of chemistry was that this was a school subject and metallurgy was not. Moreover, only a fraction of chemistry students went into industry. The bulk trained as teachers and were encouraged to do so because of the Burnham scale of payment for teachers.

Professor J. H. ANDREW said the course at Cambridge was an excellent one for Cambridge University. It concentrated on the purely metallurgical side, but there was too much tendency to regard the metallurgist as being solely concerned with the physical chemical side of the subject and a great tendency to neglect the practical application which was so necessary if a university man wished to go into industry. A real metallurgist must be able to apply his knowledge to works practice and unless that was the aim the universities were not giving the industry quite the right type of man. At Sheffield University there were two courses, one for non-ferrous and the other for ferrous metallurgy and four years ago a degree in foundry science was established. Students were actually shown how to make bad castings and then made to understand why they were bad, and how to correct them. There was also a grounding in the physical side including atomic structure, X-ray analysis, electrical diffraction and spectrographic analysis, and the knowledge so gained was applied to practical operations. Unless the theoretical work was applied under practical conditions, the metallurgist ceased to exist and the student became a physical chemist. It was also essestial that the student should go into the works during the summer vacation. There had not been many entries for metallurgy because the industry did not offer opportunities; at the same time, if the universities offered industry something which was of greater use, he believed industry would find greater opportunities and the number of students coming forward would be greater. He suggested the formation of a committee of industrialists and teachers of metallurgy which would let each other know what the other wanted.



Professor R. S. Hutton.

Misguided Research Work

There was a great deal of misguided research work and too much tendency to rush into print, continued Professor Andrew, a committee might be formed is the non-ferrous metal industry to advise individual research workers as to how they could usefully employ themselves. The iron and steel industry had done a good thing in the formation of research committees, the chairman of most of them being Dr. Hatfield, and these committees suggested industrial problems for individual workers, the result being that real scientific work of a useful character was being done. Something of the same sort should be done in the non-ferrous metal industry.

MR. A. J. G. SMOUT, speaking as as industrialist, said this discussion was very much overdue. Too much time had been devoted by the Institute to many papers which were very little better than student's exercises and very little had been done in the way of constructive thought as to the best method of dealing with the very life-blood of the industry. Personally he would welcome a paper at each meeting dealing with some aspect of the economics of the industry. A great deal of time and thought was given by the industry to staff selection and training and fitting each individual to the position in the team for which he was most suited.

Was it realised how much coming and going there was in

the industry, asked Mr. Smout? At one end of the scale there were the men of 55 to 65 years old giving the industry the benefit of their experience before retiring; then there were the middle aged men of 45 to 55 bearing the heat and burden of the day; there were the men of 35 to 45 full of pride and loyalty, and there were those of 25 to 35 just getting their feet on the ladder. These were the four stages of the average man's career. Now they were concerned with the pre-industrial stage. The product of the universities during the past 20 years, in the metallurgical sense, was such that industry had not been able to recruit as much from that source as it wished. In consequence, it had been compelled to draw from a wider field which, perhaps, was not a bad thing for industry nor had it been detrimental to the universities, because the result had been that there were on the metallurgical staffs in this country now men doing metallurgical work who were not primarily trained as metallurgists. Many of them were chemists—some organic chemists—physicists and men trained for other branches of natural science. That was all to the good because it had widened the outlook of the staffs considerably and it had broadened the basis of attack on industrial problems.

So-called "Hall Marks"

Whilst such institutions as the University of London and the Institute of Chemistry would not confer the hallmark on the thousands of young men who were doing a job of work by day and then put in three or four evenings a week in order to qualify in the higher positions, the industry was not unduly impressed by so-called hall marks. Such simple things as intellectual honesty, imagination, ability to work with their fellow men, personality, character, experience and energy conferred the hall marks required by industry. The great need was for closer co-operation between the universities and industry, but in this country it was very difficult to get the heads of university metallurgical departments into the factories. The number who had been in his works during the past 30 years could be counted on the fingers of one hand, yet he had been visited by members of the teaching professions in Germany and all over the world. He wished to see the men who were responsible for the training of the students, and to be able to discuss the requirements of industry with them. The whole object of this training should be to raise the status of the industry and with that object in view he put the three following points to those responsible for the training of metallurgical students. They should get into close touch with industry; they should not attempt to produce what was sometimes termed the practical physics man; and from the day the metallurgist entered the works he must learn to work with his fellow men.

Sir HAROLD CARPENTER, F.R.S. (Royal School of Mines) remarked that when, 25 years ago, he was called to the chair of metallurgy at the Royal School of Mines he did what Mr. Smout had said was necessary; he consulted a number of leading industrialists in this country and in America and their advice was that the universities should concentrate on fundamentals. It was on this basis that the four year course at the Royal School of Mines had been arranged. The training was in the principles of metallurgy viewed as broadly as possible and there was no specialisation. A man going into a works was no good for a time; he had to get the works atmosphere and if he were properly trained he could adapt himself very quickly. The course gave a good training in chemistry and physics and if the student was of the right type he would be able, in a comparatively short time, to take in hand any problem with which he was faced.

Dr. W. H. HATFIELD, F.R.S., agreed with what Sir Harold Carpenter had said and added that industry was more likely to obtain men who would be immediately useful if they took them from the Royal School of Mines. Therefore, universities which were ambitious to create metallurgical schools should take a leaf out of Sir Harold Carpenter's book. He regarded the Royal School of Mines and Sheffield University as the principal centres at the present time for men for the metallurgical industry. In Sheffield men engaged in the works could obtain academic training at the university in the evening, and he had found those coming from the university with a specialised metallurgical knowledge were immediately more useful. Taking the long view, Dr. Hatfield said that with his experience he would say that a man intending ultimately to enter metallurgy, should have as complete a training as possible in physics, mathematics and chemistry before entering on metallurgy, but the subject was an extremely difficult one and it was impossible to make generalisations which would apply all round. He disagreed with Mr. Smout that the Institute of Metals or the Iron and Steel Institute and the other engineering institutions were the place to discuss economics. He further disagreed with Mr. Smout in what he had said of the papers by young members of the Institute. They had all been reviewed by the publication committee before being passed for presentation, and in his own case he knew what an encouragement it had been to him as a young man to present papers. Further, he disagreed with Mr. Smout in his remarks as to the period of usefulness of men in the industry and said he could not imagine Mr. Smout arriving at the age of 25 without being useful! On the whole, concluded Dr. Hatfield, he felt the universities were producing the right type of man and there was no need for very much change.

Principal G. PATCHIN said he represented the technical college point of view. He was trained as a metallurgist and was pleased to hear that the technical colleges were playing a real part in this matter of educating men for the metallurgical industries. It was a very definite advantage to sandwich the industrial life with the educational life, although it was a little hard for young men to work hard all day and then have to spend the greater part of their evenings in learning the fundamentals. He suggested it would be advantageous if a joint discussion could be held by the Institute of Metals, the Iron and Steel Institute, and the Institution of Mining and Metallurgy, on the whole question of the training of metallurgists, because this involved more than non-ferrous metallurgists.

Dr. MAX HAAS, lecturer in the Technical High School at Aachen, who said he regarded this discussion as of international importance.

Dr. A. G. C. GWYER (British Aluminium Co.) said he was engaged partly on the industrial side and partly on the academic side and having started his career as a chemist he was inclined to think that metallurgists of the future would have to consider starting their careers in the same way. It had been said there was a shortage of metallurgists, but apart from the reason that had already been mentioned he suggested another was that metallurgy was so little known to the man in the street and the opportunities were not appreciated. Therefore, it would be well for the appointments boards of large firms to keep more in touch with headmasters and science masters in schools. He agreed with Sir Harold Carpenter as to the type of training a metallurgist should have, but there was one aspect which had not been mentioned, and that was that when the student got to the stage in the course when he took up metallurgy, there should not be too strong a specialisation in the non-ferrous or ferrous extraction process side, because it was never quite certain which side he would go into. The training should therefore be as broad as possible and not too highly specialised.

Dr. HUME-ROTHERY said he had been told by industrialists that they found it better to take men who had been trained as physicists or chemists rather than those who had been trained as metallurgists; such men were found to have a more elastic mind and one more readily adaptable to works problems than men who had been trained as metallurgists.

Professor C. O. BANNISTER expressed agreement with the view that there should be a general training without too much specialisation and also expressed the view that metallurgical training paid too little attention to analysis and assay. In many cases this was relegated to the background but it was a mistake, because whatever else a man did in the works he

would have to discuss analyses with the chemist and study the figures relating to complex ores and alloys. Having had a fairly long experience of teaching metallurgy he said he had come to the conclusion that to include anything of a semi-commercial nature in the university course was a waste of time and money.

Professor F. C. THOMPSON said a point which had not been adequately stressed as that there are two fairly distinct types of metallurgical training required, viz., the relatively vocational type which was given in the technical colleges, and the more fundamental type of training for which the university was obviously the proper place. It should, however, be stressed that any feeling that the technical type of training was less important from the national point of view than the university type, was definitely unsound, for both were essential to the national economy, in his view.

Iron and Steel Institute

Annual Meeting and Symposium on Steelmaking

THE annual meeting of the Iron and Steel Institute will take place at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, on May 4.

In conjunction with this meeting, a symposium on steelmaking, with special reference to acid and basic open-hearth practice, will be held. Twenty-one papers descriptive of the plant and practice at representative steelworks in the principal steelmaking districts of Great Britain will be read and discussed, as well as a paper on the metallurgy and physical chemistry of steelmaking in the acid and basic open-hearth furnace, and one on the correlation of British open-hearth data.

After the meeting the papers and the discussion on them, completed by a bibliography on the physical chemistry of steelmaking by the open-hearth process will be bound together to form No. 22 in the Iron and Steel Institute Special Report Series.

At the general meeting of members on Wednesday, May 4, the newly-elected president, the Earl of Dudley, will be inducted into the chair, and the Bessemer gold medal for 1938 will be presented to Dr. C. H. Desch, F.R.S. The award of the Andrew Carnegie gold medal for 1937 will be announced, and the Williams prize for 1937 will be presented to Mr. W. Geary.

The annual dinner of the Institute will be held at Grosvenor House, Park Lane, London, W.1, on Thursday, May 5, at 7 for 7.30 p.m. Tickets are 15s. each, exclusive of wine.

Papers to be presented at the May meeting will include :— Special Report No. 20. " The Application of Time Study to Rolling Mills" (Rolling Mill Committee of the Iron and Steel Industrial Research Council). Special Report No. 21. " The Fifth Report of the Corrosion Committee " (Joint Committee of the Iron and Steel Institute and the British Iron and Steel Federation). " Comparison of the Tensile Deformation Characteristics of Alloys at Elevated Temperatures " (C. R. Austin and H. D. Nickol). " An Experimental Inquiry into the Interactions of Gases and Ore in the Blast-Furnace. Part V.— The Influences of Hydrogen and Steam at 450-850° C." (W. A. Bone, F.R.S., H. L. Saunders and H. J. Tress). " Influence of Composition and Treatment on the Rate of Acid Attack on Mild Steel " (C. A. Edwards, F.R.S., D. Luther Phillips and D. F. G. Thomas). "The Effect of Copper on some Alloy Steels " (R. Harrison). " Martensitic Grains in Rapidly-Cooled Ingot Iron and Mild Steel " (B. Jones and N. Gray). " The Effect of Chromium and Carbon Contents on the Co-efficients of Thermal Expansion of Chromium Steels " (J. A. Jones and W. C. Heselwood). " Solidification in Open-Topped and Closed-Topped Ingot Moulds " (B. Matuschka). " The Exact Quantitative Estimation of Ferric Oxide and Sulphide Sulphur in Basic Slags " (E. Maurer and F. Haderer). " The Atmospheric Corrosion of Galvanised Iron Wire and Its Bearing on Specification Testing " (C. E. Richards).

Papers which are being contributed to the symposium on steelmaking include :—" Basic Open-Hearth Practice in Scotland " (J. P. Fairgrieve and J. Gibson). " Manufacture of Plain Carbon Acid Steels " (J. M. Ferguson). " Some Aspects of Slag Control in Melting Practice " (R. Hay, J. M. Ferguson and J. White). " Open-Hearth Steelmaking as Practiced at the Irlam Works of the Lancashire Steel Corporation, Ltd. " (J. Sinclair Kerr, J. V. Morgan, W. Goldsbrough and D. Binnie). " The Barrow Hæmatite Steel Co., Ltd." (J. W. Danks and V. W. Davidson). " The Steel Plants of the Frodingham District, Scunthorpe " (J. B. R. Brooke, S. R. Isaac and A. Robinson). " The Appleby-Frodingham Steel Co.'s Melting Shops" (A. Robinson). "John Lysaght, Ltd., Normanby Park Steel Works, Scunthorpe " (J. B. R. Brooke). " The Redbourn Works Melting Shop of Messrs. Richard Thomas and Co., Ltd." (S. R. Isaac). " Acid and Basic Open-Hearth Practice on the North-East Coast " (Frank Bainbridge, W. Geary, James Winter and P. W. Wood). "Practice at the works of the South Durham Steel and Iron Co., Ltd., and Cargo Fleet Iron Co., Ltd." (James Winter). " Open-Hearth Acid and Basic Processes at Consett " (P. W. Wood). " Plant and Practice at works of Dorman, Long and Co., Ltd." (W. Geary, L. E. Crooks and E. Drewery). " The Melting Shop of the Skinningrove Iron Co., Ltd." (Frank Bainbridge). " Acid Siemens Open-Hearth Process " (E. Dawtry, W. H. Hatfield, R.R.S. and C. W. Wright). " Making Basic Open-Hearth Steel for Many Purposes " (R. Percival Smith). " Basic Open-Hearth Steelmaking Practice of the Park Gate Iron and Steel Co., Ltd., Rotherham " (R. T. Lintern and R. A. Hacking). "Some Experiences in the Design and Control of Open-Hearth Furnaces " (R. J. Sarjant and E. J. Barnes). " Steelworks Refractories " (T. Swinden and J. H. Chester). " The Mixed-Gas Melting Shop of Guest Keen Baldwins, East Moors, Cardiff " (James A. Davies). " A Tilting Furnace Fired with Cold Coke-Oven Gas " (R. W. Evans). "The Application of Physical Chemistry to Steelmaking " (A. McCance). " Open-Hearth Data and their Correlation " (Open-Hearth Committee of the Iron and Steel Industrial Research Council).

Autumn Meeting in New York

By invitation of the American Iron and Steel Institute and the American Institute of Mining and Metallurgical Engineers, a joint autumn meeting of the Iron and Steel Institute and the Institute of Metals will be held in New York, October 3 and 4. After the meeting a tour will be made of important industrial centres in the United States. Before the meeting, members of both British institutes are invited by the Canadian Institute of Mining and Metallurgy to visit Canada. Full particulars can be obtained from the Organising Officer, Joint Meeting, 28 Victoria Street, London, S.W.1.

Hot Tinning Methods

PRACTICAL details of methods employed in tinning metal articles of all descriptions are given in a new publication of the International Tin Research and Development Council. (" The Hot-Tinning of Fabricated Articles," by E. J. Daniels). Degreasing, pickling and fluxing of the articles prior to the actual tinning are discussed and formulæ are given for the baths suitable for the varying types of articles. These include articles made of copper and steel such as tubes, hollowware and wires, and also cast iron. The difficulties sometimes met in tinning brass, bronze and aluminium necessitate special treatments for these metals.

Letter to the Editor

Lead in Nickel Plating Baths

SIR,—The article on lead in nickel plating baths and the subsequent correspondence on this matter, in the Metallurgical Section of THE CHEMICAL AGE, has been read with great interest and we believe that in actual practice it has been established beyond doubt that the presence of lead does cause a number of difficulties, especially where there are chlorides present. We know that hard rubber linings can be used instead of lead and to some extent overcome these troubles, but when the rubber surface blisters or cracks the metal or concrete wall of the plating tank is exposed and is rapidly corroded by the plating solution. This also applies to the racks, jugs and other fittings utilised for suspending the articles that are being plated. Hard rubber or ebonite linings tend to give trouble above a maximum temperature of 8° C.

If, however, instead of a lining a solid material is used it has many advantages without the difficulties mentioned above. Keebush offers all these advantages and is not only unaffected by chlorides or sulphates, but new outlets and fittings can be put in such a tank, or old ones filled up if required, without affecting the acid resisting properties. It can readily be moulded in the form of tanks and fittings, it has a high dielectric strength, and does not depend on surface conditions for its resistance to chemical attack.—Yours faithfully,

BRIAN N. REAVELL,
Kestner Evaporator and Engineering Co., Ltd.

Institute of Metals

Annual Meeting and Dinner

THE 13th annual general meeting of the Institute of Metals was held in London, March 8-10. The president, Mr. W. R. Barclay, was in the chair at the opening of the proceedings, his place being taken later by the new president, Dr. C. H. Desch, F.R.S.

The year ended December 31, 1937, according to the report of the council of the Institute, was one of exceptional activity and of considerable progress in many directions. Membership again showed an increase over the previous year, and in the hope that the growth will continue the council has been encouraged to develop plans for the improvement of publications and to engage in discussions with the Iron and Steel Institute for closer collaboration and for increased joint responsibilities in several directions. The raising of an endowment fund which now promises to reach £20,000, has appreciably strengthened the financial position.

The growth in the membership envisaged in the last annual report continued, and the total on December 31, 1937, 2,166, was the highest reached since the record figure of 2,232 was attained in 1931. The large increase in the number of student members has been particularly gratifying to the council, as also is that in the number of associate members who have joined as a result of the scheme of co-operation with the American Institute of Mining and Metallurgical Engineers. The total of ordinary members includes members of the Iron and Steel Institute who have joined under the scheme of co-operation which was referred to in the last annual report.

Election of Officers

The following new officers were elected for the year 1938-39:—President, Dr. C. H. Desch, F.R.S. Vice-president, Professor J. H. Andrew. Members of Council, Dr. J. W. Donaldson, Engineer Vice-Admiral Sir George Preece, and Mr. H. S. Tasker.

Nearly five hundred members and their friends were present at the annual dinner and dance of the Institute, at Grosvenor House, London, on March 9. Among the distinguished guests was Sir William Bragg, the first recipient of the Institute's medal. Friends from Germany included Dr. W. J. P. Rohn, who represented the Deutsche Gesellschaft fur Metallkunde and the Verein Deutcher Ingenieure.

Nickel Silver Standard

Specification Issued for Sheets and Strip

THE British Standards Institution has just issued a British standard (No. 790-1938) for nickel silver sheets and strip.

Although official specifications for various grades of nickel silver alloys have been published in the United States by the government and other large organisations, this publication of the British standards is the first to be made in Europe. The large number and complexity of these alloys in use both in this country and on the continent made the work of selection extremely difficult, and it is to the credit of those co-operating in the preparation of the present specification that some measure of standardisation in this field has been brought about.

The specification, which covers material up to and including 3 S.W.G. in thickness, provides for seven standard grades of nickel silvers ranging from 10 per cent. nickel to 30 per cent. nickel, in four tempers, namely, annealed (soft), half-hard, hard and extra-hard.

The constitution of the committee entrusted with the preparation of the specification was as follows:—Mr. W. R. Barclay (chairman), Mr. C. Coldron Smith and Mr. J. Hall (Admiralty), Dr. R. Genders (War Office), Mr. F. S. Clare and Mr. G. Meikle (Air Ministry), Mr. F. O. Barralet (General Post Office), Dr. C. H. Desch (National Physical Laboratory), Mr. G. L. Bailey (British Non-Ferrous Metals Research Association), Mr. W. R. Barclay and Mr. H. B. Weeks (Institute of Metals), Mr. H. J. Miller (Copper Development Association), Mr. W. B. Parker, Mr. H. M. Duncan and Mr. S. Palmer (British Electrical and Allied Manufacturers' Association), Mr. W. H. Henman (Nickel Silver Association), Major Gilbert Dennison (Birmingham Jewellers' and Silversmiths' Association), Mr. Bryan Hodgson (British Corporation Register of Shipping and Aircraft), Mr. J. Cooper (Master Silversmiths' Association), Dr. L. Aitchison, Dr. H. W. Brownsdon, Mr. W. T. Griffiths, Dr. R. S. Hutton, Mr. F. L. Miskin and Professor F. C. Thompson.

Copies of the specification may be obtained from the Publication Department, British Standards Institution, 28 Victoria Street, London, S.W.1, price 2s., 2s. 2d. post free.

Recent Metallurgical Patents

Purifying Metals and Alloys

In a Bessemer process for the purification of iron, steel nonferrous metals and ferro-alloys, the metal bath is first blown with a blast of oxygen-enriched air until the major portion of the oxidisable impurities has been removed and then with a blast of air enriched with nitrogen or its equivalent until the removal of the impurities to the desired extent has been completed. The surplus nitrogen separated from the air used to produce the oxygen for enriching the blast may be used for diluting the blast for the second part of the blow. Instead of nitrogen, one or more gases in Group O of the periodic table may be used. (See Specification 472,397, of Electro Metallurgical Co.).

Cementation

A carbonised surface is produced on metals or alloys by heating a carbon-containing metal or alloy in a vacuum, or in an atmosphere incapable of reacting with the carbon, *e.g.*, in nitrogen, argon or helium, until a firmly adhering film of carbon is formed on the surface, the metal or alloy being substantially devoid of oxygen or other substance capable of being driven out of the metal, etc., during the heating, and of combining with the carbon. The treatment of nickel containing at least 0.1 per cent. of carbon is referred to, and if the carbon content is 0.25 per cent. or over the temperatures used are 500-950° C. The treatment may be applied to the manufacture of electrodes for electron discharge tubes and the carbonisation may be carried out within the envelope of the tube after exhaustion thereof and simultaneously with the degasefication of the electrodes. (See Specification 472,825 of E. W. Skelton).

Metallurgical Section

May 7, 1938

Current Topics

Temperature of Liquid Steel

SOME investigations of particular interest to steel makers and users were carried out at the National Physical Laboratory during 1937, as disclosed by a report now published. Concerned about means for determining the temperature of liquid steel in the open-hearth furnace, a joint committee of the Iron and Steel Institute and the British Iron and Steel Federation has attempted to render possible the use of one or both of the two instruments best suited for high-temperature measurement, namely, the platinum thermo-couple and the optical pyrometer. These instruments are limited in their application to the problem by the shortcomings of refractory materials, none of which will stand immersion in liquid steel, with its coating of slag, in such a way as to provide a satisfactory sheath for a thermo-couple or a black-body radiator for the optical pyrometer. In the first stage of the investigation it was shown, by small-scale laboratory experiments, that thin-walled tubes of silica or silicon carbide will withstand plunging into steel, without its slag coating, and attain a temperature equilibrium in 10 to 15 seconds, and still further, that a platinum couple lightly sheathed in silica shows no sign of contamination on repeated immersion. In the next stage of the investigation, an attempt is being made to obtain slag-free conditions in an actual open-hearth furnace, such as will allow the "quick-immersion" technique developed in the laboratory to be brought into action. Experiments carried out on furnaces at Sheffield have already given very promising results.

Transformation Temperatures of Steels

AT the request of the Thermal Treatment Sub-Committee, heating and cooling curves of twenty-one typical carbon and alloy steels have been determined under carefully controlled conditions. Several special features have been noted, and the work has now reached the report stage. It is intended to correlate the results with the known changes of micro-structure produced under the various conditions of heating and cooling the steels, and with other physical and mechanical properties. A few experiments have been made on the effect of strain on the temperature of occurrence and on the temperature hysteresis of the critical points of alloy steels, and although this particular investigation is in its preliminary stages, some encouraging results have been obtained.

Intercrystalline Cracking

INVESTIGATIONS in intercrystalline cracking have been mainly confined to the light alloys of aluminium with copper and zinc. It is concluded that the mechanism of failure of specimens in air under load is essentially the same as when the specimens are exposed to salt spray, which causes failure in a much shorter time, and that chemical action is concerned in both cases. Experiments with a commercial aluminium alloy have shown the great importance of the speed of quenching after the annealing process needed to bring the constituents into solid solution. Thin strip material cooled in air or quenched in boiling water suffered from intercrystalline attack when exposed to sea-water spray, and also failed by rupture under continued load. The same material, quenched in cold water or in oil, did not undergo intercrystalline attack, and although general corrosion occurred it was not hastened by the application of a load.

The cracking of boiler plates is also one of intercrystalline attack. At a conference held early in 1937, four reports were presented, dealing respectively with (1) the effects of prolonged stress on specimens of iron and steel immersed in hot sodium hydroxide solutions; (2) strain-etching patterns observed in boiler plate material; (3) observation of the behaviour of iron and steel exposed to various solutions in small pressure cylinders; and (4) examination of defects found in the corroded boilers of certain ships. It is found that under laboratory conditions the presence of sodium silicate, to which the failure has been attributed, may be without influence. This investigation is now in its final stages, and will be reported this year.

Pig-Iron Import Duty

PIG-IRON stocks are now reaching a level which makes it highly probable that an early application will be made to the Import Duties Advisory Committee for a restored duty on imported supplies. It was a serious shortage about a year ago, at a period when the British Steel industry was almost overwhelmed with orders, which led to the withdrawal of the former $33\frac{1}{3}$ per cent. import duty. As a consequence considerable quantities of pig-iron have been imported during the past twelve months and meanwhile home production has increased substantially. For the first three months of the present year the output of the home industry was 2,169,000 tons, as compared with 1,934,000 tons in the January-March quarter of 1937, representing an increase of about 12 per cent. Both steel and pig-iron production in the United Kingdom were higher in March, 1938, than in March, 1937, and also higher in February, 1938. If the present rate of steel production continues until the end of the year the record output of 12,964,000 tons in 1937 will be slightly exceeded. About 75 per cent. of the current production of steel is being absorbed through normal commercial channels, the remainder being consumed in the manufacture of armaments. A sudden acceleration of the armaments programme could easily place a strain upon the production capacity of the steel makers, but present indications are that several months must pass before the "impact" of the present acceleration desired by the Government is felt by the manufacturers.

"Frostiness" in Plumber's Solder

AN investigation on the working properties of plumbers' solder having a frosty surface has just been completed by the British Non-Ferrous Metals Research Association with the aid of funds provided by the International Tin Research and Development Council. In a report now published, F. A. Rivett points out that bad working properties and frostiness may both be produced by traces of impurity, and frostiness has therefore come to be considered an almost infallible indication of inferiority. Frostiness is, however, produced on good solder cast into an overheated mould and in this case is due to the growth of large crystals. Frequently, when material returned as unsatisfactory is analysed, nothing can be found in the composition to explain bad working properties, and another batch of solder from the same pot and of identical composition is found to be quite satisfactory. It is therefore tolerably certain that any explanation of these alleged differences in working properties must lie in some factor other than composition, and that frostiness is not invariably a sign of poor solder. Traces of zinc, aluminium or cadmium are known to produce a "frosty" appearance (C. L. Barber, *Ind. Eng. Chem.*, 1934, *26*, 685), and these impurity metals are generally accepted as detrimental to the working properties of a solder. This seems to have led plumbers always to associate "frostiness" with bad working properties, and may have caused the rejection of material which is in reality quite satisfactory.

Electrodeposition of Nickel-Cobalt Alloys

WITHIN the past two years the electrodeposition of nickel-cobalt alloys has attained commercial importance, mainly as a result of the discovery that the presence of sodium formate and formaldehyde in the sulphate bath makes possible the production of lustrous alloy deposits which require no buffing or colouring. In the United States the volume of nickel-cobalt plating solution now in use is well over 25,000 gallons, and the consumption of cobalt-nickel anodes has attained an annual rate of 100,000 lb. Studies described in a paper by L. Weisberg (*Electro-chemical Society*, Preprint 73-1, 1938), were made on sulphate baths containing chlorides and boric acid, solutions essentially similar to those in general use for nickel plating. It was found that the addition of cobalt to ordinary nickel-plating solutions is not sufficient to produce bright deposits: other additional substances are required to secure acceptable bright plating. A typical bath for producing bright deposits consists of nickel sulphate 32 oz. per gallon, nickel chloride 6 oz., sodium formate 4.6 oz., boric acid 4 oz., cobalt sulphate 2 oz., ammonium sulphate 0.3 oz., and formaldehyde 0.12 oz. A reasonable amount of control of composition is required, but the limits for production of bright plating are not highly critical. Typical operating conditions are pH = 3.7 (quinhydrone electrode); average current density, 40 amp. per sq. ft.; temperature 60° C. Agitation of the solution or vigorous motion of the work is essential; agitation is preferably produced by mechanical stirring or by means of air. The anodes contain about 18 per cent. cobalt. For deposits made under these conditions it is claimed that the brightness can be maintained for deposits of much greater thickness than is commercially required. Contrary to usual experience, it has been found that the brightness of the surface increases with increase in thickness.

Nickel- cobalt alloys may be plated directly on brass or steel, or on copper-plated steel. For plating on zinc-base die castings an under-coat of copper should be deposited from a cyanide bath to which Rochelle salt is added. Freedom from impurities is an essential factor in the production of bright deposits. Copper, lead, iron, zinc, chromium and organic matter are cited as being injurious contaminants; the absence of impurities is a condition for obtaining deposits showing good ductility. The deposits are finding their main application as an undercoat to chromium; they are also being used under electro-deposits of silver and gold. The corrosion-resistance of the coatings is believed to be equal to that of nickel plate of equivalent thickness.

Copper in Cast Steel and Iron

A COMPLETE summary of the effect of copper as an alloy addition to cast steel and cast iron has been published by the Copper Development Association. In view of the comparatively recent development of copper as an alloy addition a large amount of work appears to be covered. In current commercial practice copper has become an important addition in regular use. Sections of the book which are of special concern refer to the influence of copper on both blackheart and whiteheart malleable cast iron and on ordinary cast iron. Copper is essentially a graphitiser which can be used to replace silicon in part, or to balance the effect of hardening elements such as manganese, molybdenum and chromium. Reference is made to work carried out by the Copper Development Association, including the effect of copper in producing complete graphite refinement when present to the extent of about 6 to 8 per cent.

Beryllium-Copper Alloys

THE alloys of copper and beryllium, known as beryllium bronzes, are showing a growing field of application. Casting and cold working properties are very satisfactory, and an extraordinary response to heat treatment makes these alloys especially suitable for some special purposes such as high-fatigue springs and high-speed bearings. The addition of beryllium to copper, however, finds certain difficulties because of the loss of beryllium at high temperatures, and attempts have therefore been made to produce the alloys direct by the electrolysis of fused salts using a cathode of molten copper. The results of some recent work along these lines is described in a paper which Colin G. Fink and Tsing-Nang Shen read before the Electrochemical Society in the United States. It was found that the current efficiency in the reduction of beryllium was of the order of 40 per cent., but that an alloy containing 2.85 per cent. beryllium could be produced from a bath consisting of 50 per cent. beryllium oxyfluoride, 34 per cent. sodium fluoride and 16 per cent. barium fluoride. In Germany beryllium-copper alloys are produced by adding finely divided copper to a fused beryllium oxyfluoride bath in a graphite container which serves as the anode. Here the copper sinks to the bottom of the bath and is converted to the fluoride by the fluorine which is discharged at the anode. Copper and beryllium are then deposited simultaneously at the cathode.

Effect of Chromium and Carbon on Coefficients of Expansion of Chromium Steels*

By

J. A. JONES, M.Sc., F.Inst.P., and W. C. HASELWOOD, B.Sc., A.Met.

IN view of the increasing demand for steels with specified values for the mean coefficient of expansion over a given range of temperature, a systematic study of the effect of various alloy elements on the values of the coefficient of thermal expansion of steel has been proceeding for some time in the Central Research Department of The United Steel Companies, Ltd.

Chromium steels were dealt with first, as alloys with a wide range of chromium content are now used commercially, many of them in high-temperature services.

Results of Previous Investigations

The results of previous investigations summarised by Greaves ("Chromium Steels," 1933, H.M. Stationery Office) indicate that an increasing chromium content progressively reduces the coefficient of expansion, while variations of the carbon content normally met with in chromium steels have only a small effect. In view of the absence, in many instances, of exact details of the composition or treatment of the steels and of the accuracy of the determinations, it was decided to redetermine the data on a series of steels made under the same conditions and containing the minor elements in amounts similar to the minimum contents normally found in commercial steels.

The tests were carried out in a specially constructed dilatometer, in which the differential expansion between the metal specimen and similar specimens of fused silica is arranged to rotate a mirror by means of suitable extension rods. The rotation of this mirror is observed by the usual telescope-and-scale arrangement. Particular attention has been paid in the design of the furnace to ensure (1) that the temperature is uniform along the whole length of the test-piece, and (2) that the specimen, the silica reference rods and the thermocouple are all at the same temperature.

In the centre of the furnace is a heat-resisting steel block, 6 in. by $1\frac{3}{4}$ in. in dia. Parallel to the axis of the block are four holes each 9/32 in. in dia., symmetrically situated at the corners of a $\frac{5}{8}$ in. square. The metal specimen is 4 in. by $\frac{1}{4}$ in. in dia. and rests in one of the holes in the block, similar specimens of fused silica, and a thermocouple for temperature measurement, resting in the other three holes.

The furnace winding is 10 in. in length and is wound on a refractory tube $3\frac{1}{2}$ in. in dia. Between, and concentric with the heater and the block, is a heat-resisting metal tube, 10 in. by $2\frac{1}{2}$ in. in dia. The heat from the winding has, therefore, to pass through the refractory tube, across an air-gap, through the metal tube and across a second air-gap to the block containing the rods. The outside of the furnace is well lagged with insulation powder, the outside case being double and consisting of two highly polished stainless-steel cylinders.

During a test, a slow stream of dried nitrogen is passed through the furnace to minimise the oxidation of the specimen.

Disposition of the Specimens

Fused-silica extension rods project out of both ends of the furnace from the specimens. The ends of the specimens and of the extension rods are bevelled, the object of the bevel being to provide a space for any extraneous particles rather than allow them to settle between the contact faces during assembly or during the test. On one side the extension rods connect to fine screw adjusters, and on the other side to three steel rods hardened and ground to a good sliding fit in a suitable metal head, each rod being lightly spring-loaded to maintain contact between the specimen and the extension rods. The outer ends of the steel rods are ground to a point and make contact with a hardened steel plate. The hardened plate, upon which a plane mirror is mounted, is kept in contact with the points by a weight connected to a light cord that passes over a small pulley and is attached to the centre of the plate.

With the metal and silica specimens in the positions stated, the differential expansion is confined to the horizontal plane, and the rotation of the mirror is measured by a telescope and illuminated scale set up about 11 ft. away from the mirror.

The total arrangement gives a magnification of 414, and since it is possible to estimate scale readings to 0.1 mm., length changes of the order of 1/4,000 mm., or 0.00001 in., can be observed and measured. This sensitivity on a 4 in. test-piece is more than sufficient for all ordinary purposes. The coefficients of thermal expansion are checked to 0.05×10^{-6} per °C., and are here reported to this value, corresponding to an accuracy of 0.5 per cent. or better.

Two series of steels were made in a 35 kVA high-frequency furnace of 18 lb. capacity, of the Ajax-Northrup spark-gap type. The first series contained 0.10 per cent. of carbon with chromium contents of up to 32 per cent., and the second series 0.35 per cent. of carbon with chromium contents of up to 19 per cent. The ingots were forged to $\frac{1}{2}$ in. dia. bar. The bars were heated to 940° C., and very slowly cooled in the furnace before being machined to test specimens. The analyses of the bars are given in Tables I and II. The sulphur and phosphorus contents of the steels were of the order of 0.02 per cent.

Analyses of the Test Steels

TABLE I.—*Analyses of the Low-Carbon Chromium Steels.*

Steel No.	1.	2.	3.	4.	5.	6.	7.	8.	9.
Carbon. %	0·09	0·10	0·11	0·11	0·11	0·12	0·12	0·13	0·12
Manganese. % ...	0·26	0·31	0·28	0·27	0·26	0·25	0·28	0·36	0·36
Silicon. %	0·18	0·18	0·18	0·18	0·19	0·19	0·21	0·22	0·26
Chromium. % ...	Nil.	1·38	2·90	4·76	8·12	11·96	17·48	24·53	32·27

TABLE II.—*Analyses of the Medium-Carbon Chromium Steels.*

Steel No.	10.	11.	12.	13.	14.	15.
Carbon. %	0·36	0·35	0·37	0·37	0·38	0·43
Manganese. % ...	0·32	0·31	0·33	0·31	0·34	0·35
Silicon. %	0·20	0·19	0·21	0·14	0·22	0·28
Chromium. % ...	Nil	0·75	1·57	2·68	7·67	18·88

The results of preliminary tests indicated that the steels when annealed (slowly cooled from 940° C.) were not in a stable condition, as successive tests taken up to a temperature of 700° C. were found to give different values for the coefficient of expansion. After each retest the specimens were cooled very slowly in the dilatometer, a period of 16 hr. being required to cool to 40° C. Final figures were only considered satisfactory when consecutive tests gave values agreeing to within 0.05×10^{-6} per °C.

There was a trend during repeated reheatings towards lower values of expansion coefficients in all the low-carbon chromium steels, especially in those containing 8.12, 11.96 and 17.48 per cent. of chromium.

Table III gives the results of successive determinations carried out on the steel containing 11.96 per cent. of chromium.

TABLE III.—*Results of Successive Determinations of Coefficient of Expansion on Steel 6.* Carbon 0·12%, chromium 11·96%.

Test No.	Mean Coefficients of Expansion × 10^{-6}. 20–200° C.	20–300° C.	20–400° C.	20–500° C.	20–600° C.	20–700° C.
1	$11{\cdot}5_5$	...	$12{\cdot}1_5$	$12{\cdot}4_5$	$12{\cdot}7_0$	$12{\cdot}9_5$
2	$11{\cdot}3_5$	...	$11{\cdot}9_0$	...	...	...
3	$11{\cdot}2_5$	...	$11{\cdot}8_0$	...	$12{\cdot}5_0$	$12{\cdot}7_5$
4	$11{\cdot}2_0$	$11{\cdot}5_0$	$11{\cdot}7_5$	$12{\cdot}1_0$	...	...
5	$11{\cdot}2_0$	$11{\cdot}5_0$	$11{\cdot}7_0$	$12{\cdot}0_0$	$12{\cdot}3_5$	$12{\cdot}6_0$
6	$11{\cdot}1_5$	$11{\cdot}4_5$	$11{\cdot}7_0$	$12{\cdot}0_0$	$12{\cdot}3_0$	$12{\cdot}5_5$

Similar effects were also noted in the medium-carbon steels.

It would appear that the steels in the initial annealed condition were not in true equilibrium, with the result that the

* Abstract of a paper presented at this week's Annual General Meeting of the Iron and Steel Institute.

chromium present was not exerting its full influence. As a result of the successive slow coolings from 700° C. the steels were brought into a more stable condition, and the full effect of the chromium present becomes evident in the lowering of the values for the coefficient of expansion.

Determinations of the mean coefficients of thermal expansion were carried out over temperature ranges up to 700° C. and the results are given in Tables IV and V.

TABLE IV.—*Mean Coefficients of Thermal Expansion for the Series of Low-Carbon Chromium Steels.*

			Mean Coefficients of Expansion × 10^{-6}.								
Steel No.	...	...	1	2	3	4	5	6	7	8	9
Chromium.	%	...	Nil	1·38	2·90	4·76	8·12	11·96	17·48	24·53	32·27
20–200° C.	...	...	12·9	12·6	12·4	12·0	11·5	11·1	10·7	10·4	10·2
20–300° C.	...	...	13·6	13·1	12·9	12·5	11·9	11·4	11·0	10·7	10·5
20–400° C.	...	...	14·1	13·6	13·3	12·9	12·3	11·7	11·3	11·0	10·8
20–500° C.	...	...	14·5	14·0	13·7	13·3	12·6	12·0	11·5	11·3	11·0
20–600° C.	...	...	14·8	14·4	14·1	13·6	12·9	12·3	11·8	11·5	11·1
20–700° C.	...	...	15·2	14·7	14·4	13·9	13·1	12·5	12·0	11·7	11·4

TABLE V.—*Mean Coefficients of Thermal Expansion for the Series of Medium-Carbon Chromium Steels.*

		Mean Coefficients of Expansion × 10^{-6}.					
Steel No.	...	10	11	12	13	14	15
Chromium.	%	Nil.	0·75	1.57	2·68	7·67	18·88
20–200° C.	...	12·5	12·6	12·8	12·4	11·7	10·6
20–300° C.	...	13·3	13·3	13·4	12·9	12·1	11·0
20–400° C.	...	13·8	13·9	13·8	13·4	12·5	11·3
20–500° C.	...	14·3	14·2	14·1	13·8	12·9	11·6
20–600° C.	...	14·7	14·6	14·4	14·1	13·1	11·8
20–700° C.	...	15·2	15·0	14·6	14·4	13·3	12·1

Discussion of the Results

In plotting the results, mean coefficient of expansion against temperature, for the individual steels of the low-carbon series, there was an inflection at a temperature of about 600° C. in the curve for the steel containing approximately 32 per cent. of chromium. This was quite definite and reversible on cooling from 700° C. A similar effect in chromium-iron alloys was observed by Chevenard ("Les Alliages de Fer, de Nickel et de Chrome," Travaux et Mémoires du Bureau International des Poids et Mesures, 1927, vol. 17), who associated the phenomenon with the A_2 (Curie) point. It is not clear that this is a complete explanation, since the curve for steel No. 8, in which the A_2 points occurs at 635° C., showed no similar inflection in repeated dilatation tests over a range of temperature up to 700° C. A plot showing the effect of the chromium content on the mean coefficient of expansion of the medium-carbon steels demonstrates for the temperature range 20° to 200° C., that an addition of chromium up to approximately 1.5 per cent. increases the value of the coefficient of expansion, but further additions have the effect of lowering the value. The average carbon content of the first four steels in the series of medium-carbon steels may be taken as 0.36 per cent. The chromium content at which the maximum value is obtained cannot be stated accurately, but approximates to 1.5 per cent. The ratio of the chromium to the carbon content in the steel giving the inflection is thus approximately 1.5/0.36 = 4.2.

Edwards and Norbury ("Journal of the Iron and Steel Institute," 1920, No. I, p. 447) found from the results of resistivity measurements on chromium steels that only the chromium in excess of 4.3 times the carbon content had any appreciable influence on the resistivity, and suggested that the first effect of the chromium is to form the double carbide $Fe_3C.Cr_3C_2$ (Cr : C = 4.3 : 1), after which the chromium exerts its normal effect on the resistivity. It is significant that a similar ratio holds for a maximum in the coefficient-of-expansion curves. Opinions differ as to the carbides present in low-carbon chromium steels. It would appear probable (R. H. Greaves, *loc. cit.*, chapter iv) that the carbides present in these steels are Fe_3C and Cr_3C_2 existing as a mixture, not as a compound, the chromium carbide gradually replacing the iron carbide as the chromium content is increased.

The curves of coefficient of expansion for the medium-carbon steels indicate some change in the condition of the chromium after the mixture of Fe_3C + Cr_3C_2 reaches equimolecular proportions. Maurer ("Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung," 1921, vol. 2, p. 5) found that, whereas additions of chromium to iron caused a fall in the coefficient-of-expansion values, additions of Cr_3C_2 first caused an increase, with a maximum at about 2 per cent. of Cr_3C_2 (*i.e.*, 1.75 per cent. of chromium and 0.25 per cent. of carbon).

It is possible that with increasing chromium additions no further Cr_3C_2 is formed (the first action of which appears to be to increase the coefficient of expansion), but that the residual chromium enters mainly into solution in the iron and results in a lowering of the values of the coefficient. The effect persists in decreasing magnitude with increasing temperature. With regard to the series of low-carbon steels, if a sufficient number of steels were examined with chromium contents below 1 per cent., an inflection would probably be found in the curves at approximately 0.45 per cent. of chromium, but the effect would be appreciably smaller than that found in the higher-carbon steels.

World Tin Consumption Decreased

Notably Lower Figures for the United Kingdom

According to the April Statistical Bulletin of the International Tin Research and Development Council, issued by the Hague Statistical Office, world apparent consumption of tin in the first two months of this year, at 26,400 tons, is 5,100 tons lower than the consumption for the corresponding period of last year, while world production has fallen by only 1,500 tons to 26,800 tons. Consumption statistics for the United Kingdom are available up to the end of March, and these show a decrease of 31 per cent. from 6,354 tons in the first quarter of 1937 to 4,378 tons in the first quarter of the current year.

Considering the twelve month periods ending February, 1938, and February, 1937, respectively, the largest increase in apparent consumption is shown by the U.S.S.R., which took 26,722 tons against 10,236 tons. Consumption of tin in the U.S.A. increased by about 4½ per cent. to 80,388 tons, and in the United Kingdom by 13 per cent. to 24,483 tons.

The reduced rate of world tin consumption in 1938 is explained by considerably reduced activity in the tinplate industry, especially in the United States and the United Kingdom. World production of tinplate in January-March, 1938 was 672,000 tons, against 1,022,000 tons in the corresponding period of 1937.

New Chemical Standards for Carbon Steels

Announcement of the Bureau of Analysed Samples

The Bureau of Analysed Samples announces two new standard steels which are now ready for issue :—

Free-cutting carbon steel "D"			Carbon Steel "F"
		%	%
Carbon	...	0.114	0.525
Silicon	...	0.007	0.109
Sulphur	...	0.237	0.032
Phosphorus	...	0.082	0.050
Manganese	...	0.810	1.010

Steel "D" is a typical modern high sulphur and phosphorus free-cutting steel. Steel "F" is a typical 0.5 per cent. basic open-hearth carbon steel, but with phosphorus and manganese near to the top limit which is frequently specified.

As usual, each standard has been analysed by a number of chemists experienced in the analysis of that particular class of steel. The standards are issued in bottles containing 25 grms., 50 grms., 100 grms., and 500 grms. Each bottle is provided with a certificate showing the analysis of each chemist, together with a reference to any feature of interest in connection with the determination of each element. The standards may be obtained direct from Headquarters, 3 Wilson Street, Middlesbrough, or through any of the usual chemical dealers.

New Outlets for Tin

Investigational Work of the International Tin Research and Development Council

THE second general report of the International Tin Research and Development Council, which has just been published, gives details of the main activities of the Council since the publication of the previous report in 1934. During this period the Council has continued to serve the needs of the tin-consuming industries and to conduct fundamental researches in order to develop new outlets in the future. The particular objects of the various researches are explained and the present stage of progress in each is described.

Researches on Tinplate

Tinplate, one of the biggest outlets for tin, is the subject of numerous researches designed to overcome such difficulties as are met with in the canning and packaging industries. A new, rapid, chemical method for the determination of the thickness of tin at various parts of a tinplate based on a direct loss-of-weight test which can be carried out in even poorly equipped and staffed laboratories has been devised. Other tests involving selective detinning for determining the thickness of the pure tin coating and of the underlying layer of tin-iron alloy, have been worked out.

A magnetic instrument for measuring the thickness of the tin coating to an accuracy of 1/100,000th inch has been constructed. Another instrument, devised on an electromagnetic principle, is particularly valuable as a non-destructive workshop method for rapidly measuring coating thickness.

It has been shown that a considerable proportion of the discontinuities in the tin coating are introduced after manufacture, during the cleaning and polishing. Certain effects caused by vibration in the tinning unit are also found to be significant in producing pores. The existence of periodic transverse bands has been revealed; the tin coating is thinner in these bands than elsewhere and most of the pores not associated with scratches are found there. As a result of a large number of experiments on tinplate with coatings ranging from 1 to 15 lb. per basis box, a definite relation has been found between porosity and thickness of the coating. A knowledge of the extent and nature of the correlation between these two variables is of great value as a step towards accurate specification; further, it enables the value of any process improvements to be accurately assessed.

The Council's researches prior to 1934 showed that an important field for further research would be the examination of the influence of the composition of the steel base of tinplate. Two lines of research have since been followed. In the first, the corrosion rates of typical tinplate steels in weak acid solutions were measured and correlated with their chemical compositions. This work showed that the corrosion rate increased with increase of sulphur content of the steel, from about 0.02 to 0.07 per cent., but decreased with increase of copper content, within certain limits. The second research, now in progress, aims at showing how far the same factors are operative in the actual can of fruit.

Improved Electrodeposition Baths

The alkaline sodium stannate bath for the electrodeposition of tin, described in the first general report, has been improved. This bath has a very high "throwing power" and is particularly suitable for tinplating articles of a great variety of shapes. While the acid tin sulphate solution is more attractive for many purposes, it has not been generally used in the past because of certain difficulties. An improved acid bath has now been developed, which enables smooth, ductile deposits of good protective value to be obtained.

Some technical factors involved in the continuous tin-plating of steel strip have been studied experimentally in both acid and alkaline tin baths. Special advantages were noted for the acid bath, in which it seemed that speeds of electrotinning comparable with those used for hot-tinning were feasible. Coatings having a ductility equal or superior to that of hot-dipped coatings were obtained in certain cases.

As the ordinary tin coating tends to wear rapidly in service, harder tin coatings may be expected to find uses, particularly in the food industries if the added metal is non-toxic. Hard tin coatings have been obtained by the co-deposition of another metal with tin from the alkaline bath. The tin-nickel deposits are of special interest as they are non-toxic.

The conditions under which satisfactory bronze electrodeposits can be obtained have been determined. The porosity of the coatings is very low, non-porous coatings being readily obtainable. The deposits present an attractive appearance, although they are liable to tarnish. They are finding use as a basis for chromium plating.

Smooth, adherent coatings of a hard tin alloy over many metals (especially copper and copper-base alloys) can be obtained by decomposition of a volatilised tin compound in a hydrogen atmosphere. Since recesses and irregularities are equally coated, this process has some advantages over other methods. Thus, threaded and machined parts may be evenly coated in this way, although the surfaces may not be adapted to tinning by other means.

Effects of Small Metallic Additions

Considerable progress has been made in the systematic investigation of the effects of small quantities of other metals on tin. This investigation has dealt mainly with the effects of other metals when added one at a time, and the influence of silver, copper, nickel, bismuth, iron, aluminium, manganese, tellurium, cadmium and antimony on the principal mechanical properties has now been determined. Particularly interesting results have arisen from the investigations dealing with silver, tellurium, cadmium and antimony. The addition of small amounts of cadmium or antimony to tin renders the metal amenable to heat treatment, by means of which the mechanical properties can be considerably modified. The effects of cadmium and antimony when added together to tin have been determined, and an interesting series of new alloys has been discovered. The strength of some of these new alloys is many times greater than that of any tin alloys previously known.

The systematic study of the effects of alloying on the properties of tin has been accompanied by a corresponding investigation of the constitution of the alloys thus produced. Thus, the binary equilibrium diagrams corresponding with the addition of siver, nickel, bismuth, tellurium, cadmium and antimony respectively, to tin, have been accurately determined. In the ternary cadmium-antimony-tin alloys the correlation between structure and properties has been particularly complete, and the investigation of the constitution has made it possible to select alloys amenable to heat treatment and to determine the best conditions under which heat treatment can be applied.

It has been found that the improvement in mechanical properties of tin-base bearing metals due to cadmium additions is maintained up to 150° C. This result is significant, because temperatures approaching this value are reached in service. Permanent softening of most of the alloys was found to occur as a result of annealing. Alloys of tin, copper, and cadmium, having a considerably higher tensile strength than ordinary babbitt metal, have been found. Further work is necessary to ascertain the most suitable composition of alloys of this type for use as bearing metals.

Experiments have shown that the surface of tin when exposed to air rapidly becomes covered with a very thin, invisible film of oxide. The tin oxide film is fairly protective

in the atmosphere. Outdoor atmospheres eventually break down the film and cause corrosion, whereas indoor atmospheres merely thicken the film, slowly giving a dull tarnish.

Strong alkalis are commonly used for washing tinned ware. Investigations have demonstrated that serious corrosion occurs when alkaline solutions come into contact with tin in presence of atmospheric oxygen, but that corrosion is negligible when the oxygen is removed.

The interaction between tin and lubricating oils has been studied and compared with that of other metals which are of interest in connection with bearings. It has been shown that oxidation of the oil and formation of sludge are stimulated by copper, but retarded by tin. Similar results obtained for the interaction of tin and other metals with insulating oils are of interest in connection with oils used in transformers and other electrical equipment.

The possible methods for protecting or improving the corrosion resistance of tin have been reviewed. The most promising process appears to be the strengthening of the natural, air-formed oxide film by anodic treatment. Investigation has shown that a black, tarnish-resistant film may be produced on tin, pewter, tinplate and other tinned ware by anodic treatment in certain aqueous colutions. By stopping-off parts of the tin surface, decorative effects can be obtained.

By special treatment, bronzes containing up to 14 per cent. of tin can be obtained, which can be satisfactorily worked either hot or cold and have improved mechanical properties and corrosion resistance. In view of the wide range of properties offered, applications of these high-tin bronzes may be expected. Special attention is being devoted to the study of the behaviour of the bronzes as condenser tubes.

Investigations on the addition of small amounts of tin to certain steels have shown that it is possible to roll the products into sheet and rod. The tin increases the tensile strength and lowers the ductility, but has a detrimental effect on the impact properties of the steel. In cast iron, small amounts of tin greatly increase the hardness. This property may lead to practical applications. The adverse effects on ductility and impact strength are not so serious in the applications of cast iron.

Some Recent Metallurgical Patents

Coating Metals

In the phosphatising of ferrous metal surfaces by subjecting them to a bath containing the phosphate of a metal above iron in the electrochemical series, the ferrous phosphate content of the bath is reduced by the periodic addition of an oxidising agent capable of oxidising ferrous iron to ferric iron under the conditions of the reaction. These additions are apart from and in addition to the usual replenishing. The amount of oxidising agent added is preferably insufficient to oxidise all of the ferrous phosphate. When the bath contains manganese phosphate, e.g., a mixture of manganese and ferrous dihydrogen phosphates, the oxidising agent is preferably potassium permanganate: when zinc dihydrogen phosphate is used, the oxidising agent is preferably hydrogen peroxide. The bath may contain a weak oxidising agent. (See Specification 477,910, of Pyrene Co., Ltd., and W. J. Clifford).

Coating Iron or Steel

A cyclic process for phosphatising iron or steel comprises spraying upon the metal with sufficient force to ensure thorough and uniform wetting a dilute solution containing a phosphate or phosphates not readily oxidisable by spraying through air and a small amount of free acid, draining the solution from the surface, removing the sludge produced by the oxidation of ferrous phosphate and re-spraying the solution. Ferrous phosphate is formed during the coating reaction and is oxidised when the solution is reflected from the surface in a state of sub-division. The non-oxidisable phosphates may be one or more of the dihydrogen phosphates of manganese, zinc, cadmium, and calcium, or a mixture of one or more of these phosphates with sodium phosphate, and the spraying pressure is preferably about 20 pounds per square inch. Accelerating agents, e.g., nitrates or copper compounds, may be added to the solution, the acid ratio of which is preferably as high as 10 to 1. The preferred spraying temperature is 65-75° C. To avoid sludge due to the hydrolysis of the non-oxidisable phosphates, a small amount of nitric acid is preferably added to the liquid used for replenishing the solution before re-spraying. For example a coating solution consisting of 350 lb. of sodium nitrate, 110 lb. of zinc di-hydrogen phosphate, about 1 lb. of copper carbonate, and 2,000 gallons of water may be replenished by addition of a solution containing 7.5 parts by weight of zinc dihydrogen phosphate, 1 part of 100 per cent. nitric acid, and 0.4-0.5 per cent. of copper carbonate, the nitric acid reacting with normal zinc phosphate formed by hydrolysis to produce zinc nitrate. (See Specification 473,285 of Pyrene Co., Ltd.).

Alloy

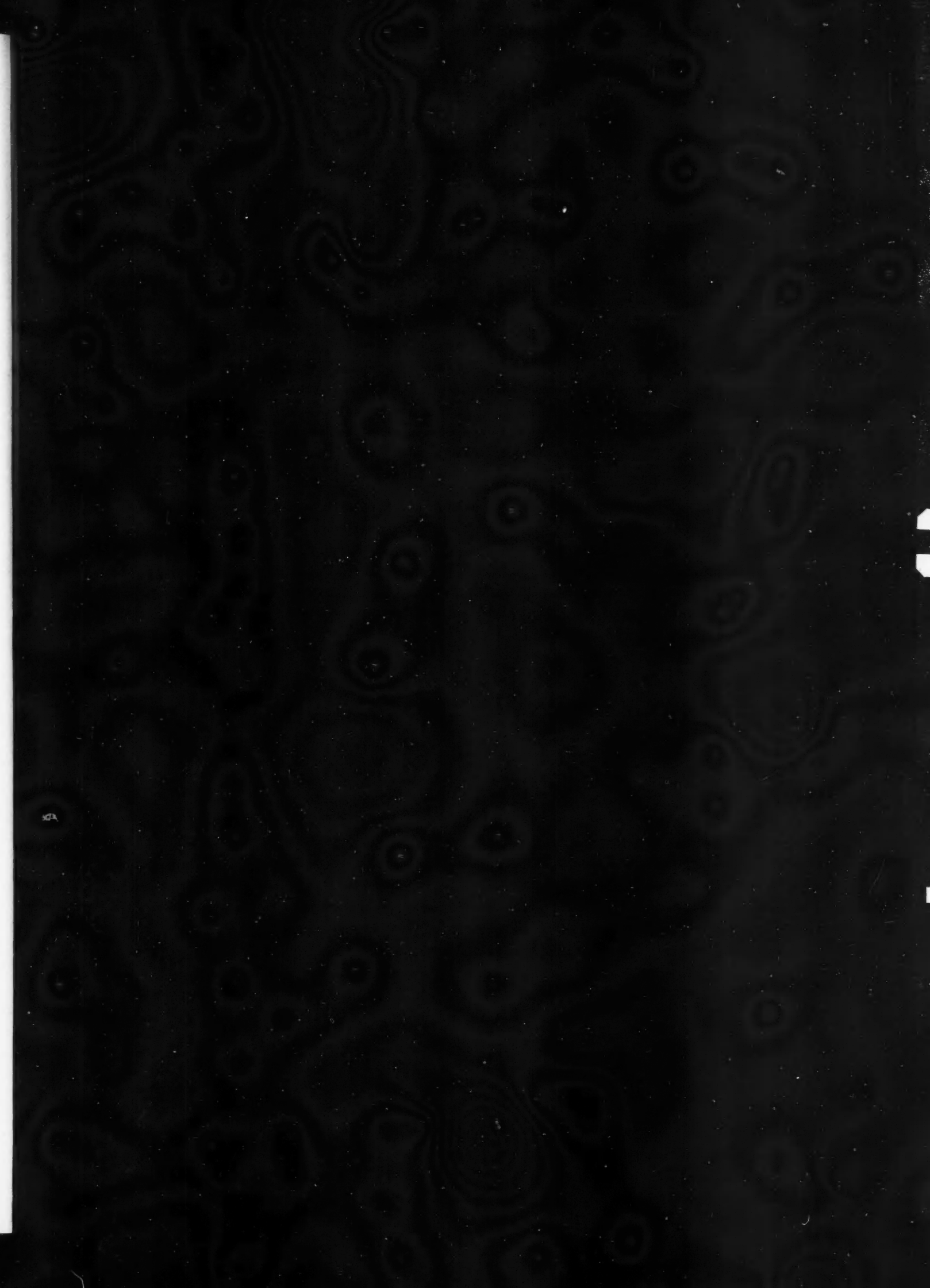
A nickel-iron alloy free from aluminium for the springs of temperature-compensated oscillating systems comprises 25-40 per cent. of nickel 0.5-2 per cent. of beryllium, and 5-12 per cent. of one or more of the metals of the group molybdenum, chromium, and tungsten and 0.6-2 per cent. of titanium. The alloy may also contain 1 per cent. of silicon and manganese together. (See Specification 477,729, of R. Straumann).

Iron Manufacture

In the production of pig iron in a blast furnace, especially from ores of low alumina content, the ores and fluxing media are mixed in such proportions as to form slags of relatively low melting points and in which the ratio of lime to silica is decreased progressively below the usual limits of 1.65 to 1.25 as the alumina content of the slag formed decreases downwardly from 15 per cent. For example with a slag containing 15 per cent. of alumina the ratio of lime to silica is from 1.15 to 0.90 and for a slag containing 10 per cent. of alumina the ratio is 1.10 to 0.875. The molten iron tapped from the furnace is desulphurised either by the addition of alkali or by allowing the liquid iron to stand in a heated receptacle under oxidising conditions to enable manganese sulphide to be formed, sufficient manganese ores being added to the burden of the furnace, if required, to produce a pig iron having at least 0.7 per cent. of manganese. In the latter case, the iron is maintained in the hot metal mixer long enough for the manganese sulphide producer to be oxidised and the sulphur eliminated in the form of sulphur dioxide. (See Specification 475,345 of H. A. Brassert and Co., Ltd., H. A. Brassert, and T. P. Colclough).

Heat-Treating Alloys

Highly-stressed machine parts and work pieces having a wall thickness or cross-section exceeding 300 mm., are prepared from a steel having a carbon content of less than 0.18 per cent., preferably less than 0.14 per cent. and containing 1-8 per cent. of chromium, 0.1-1.5 per cent. of vanadium, 0.05-5 per cent. of nickel, and 0.1-1.5 per cent. of molybdenum, and are then heat treated to produce hardening. The steel may also contain up to 2 per cent. of manganese or silicon or both and the molybdenum may be replaced wholly or in part by 0.15-7 per cent. of tungsten. The heat treatment may consist in quenching in water or oil, followed by tempering at 600° C. (See Specification 472,464, of Dortmund-Hoerder Hutten Verein Akt.-Ges.)



Metallurgical Section

June 4, 1938

Current Topics

Silver Research in America

THE metallurgical work of the American Silver Producers' Research Project, as summarised in their recent progress report, has been distributed among several research fellows. Corrosion resistance is being investigated at Columbia University by Dr. V. S. De Marchi under supervision of Dr. Colin G. Fink; response to heat-treatment by B. S. Old, under supervision of Dr. John T. Norton, Massachusetts Institute of Technology; and the preparation of alloys is in the hands of the research associates working under the supervision of H. S. Rawdon at the Bureau of Standards.

Approximately two hundred alloys are under investigation, and while definitive appraisal cannot be made at this time, certain trends have been noted, indicating that silver is a surprisingly effective alloy hardener of the solution-forming type. Annealing studies at the Bureau of Standards have shown a general tendency of silver in amount of one to five per cent. to raise definitely the annealing temperature of wrought brass, bronze, aluminium bronze, and manganese-silicon bronze. In addition Old has shown that interesting ageing properties are developed in certain alloys. The most promising improvement produced by silver and heat-treatment has been noted in the tin bronzes, the beryllium bronze where silver replaces some of the beryllium, and the light magnesium-tin alloys.

Silicon and Silver

CONTRARY to expectations, the silver silicon alloys, rich in silver, are notable for their response to heat-treatment. A very thorough study is being made of the magnesium-tin alloys with $2\frac{1}{2}$ per cent. of silver. It is believed that the slight solubility of silicon in silver, combined with precipitation hardening properties of alloys containing less than eutectic silicon content, offer a type of alloy that can be used in the chemical and electrical industries to advantage, because of its corrosion resistance, hardness, strength, and relatively high conductivity, both thermal and electrical. Later studies will determine the practicability of adding other elements to improve the general hardness of this type of alloy.

Corrosion tests have shown that, with the exception of certain aluminium and magnesium-base alloys, the addition of up to one per cent. of silver has little if any harmful effect, although generally higher silver up to 5 per cent. may moderately accelerate corrosion in a brine solution. This seems to apply to brass, bronze, aluminium bronze, beryllium bronze, and cupro-nickels. Up to about 15 per cent. silver additions reduce the corrosion of zinc. De Marchi has produced some very interesting specimens of silver-iron alloys " from metal powders, sintered and worked to sheet." He is also studying a silver storage battery characterised by its ability to take high charge and discharge rates. A potassium chromate electrolyte (10 per cent.) has been found advantageous.

The electrodeposition of silver and silver alloys is being investigated by research fellows under guidance of Dr. F. C. Mathers at Indiana University. A procedure has been worked out for the production of thick (0.01 to 0.05 inch) adherent deposits of silver on steel. In addition to a direct deposition method, details have been worked out for a process utilising an intermediate electroplate of a third metal, particularly copper. The relationship between thickness of deposits and imperviousness of the electroplate is also being studied.

Nickel, cobalt, cadmium, copper, iron, zinc, and lead have been co-deposited with silver from aqueous solutions, resulting in deposits possessing interesting properties. For instance, silver-nickel alloys are notably hard; silver-iron alloys, while not tarnish-proof, are notably corrosion-resistant; the highest resistance to sulphide tarnish was noted in a deposit plated out of silver beryllium nitrate tartrate solution, this deposit giving a qualitative test for beryllium. Since silver deposits can readily be stripped from aluminium cathodes, the latter might serve as starting sheets for the production of films and sheets of silver.

The senior research associate at the Bureau of Standards, A. J. Dornblatt, has personally visited more than one hundred industrial and research organisations to acquaint them with the project and exchange data relating to silver. A list of metallurgical patents relating to silver alloys has been prepared, as well as a list of chemicals and the suitability of silver to withstand their attack. Since all of the research work being done on the project is " open " and none of it is subject to patent, information on any details of the Silver Research Project can be obtained from Mr. A. J. Dornblatt, at the United States National Bureau of Standards, Washington, D.C.

Plastic Flow in Metals

OPENING a discussion on plastic flow in metals at a meeting of the Royal Society on May 12, Professor W. L. Bragg, F.R.S., laid stress on the fact that a perfect metal crystal is extremely weak, and it yields to a vanishingly small shearing force. As deformation proceeds the perfection of the crystal structure is destroyed, and the resistance to shear is increased. But after severe cold-working the metal attains a steady state, with random orientation of the crystal grains and characteristic mechanical properties. Yield takes place along definite crystalline planes, and parallel to definite directions in these planes; a rod under tension develops slip bands parallel to these planes. Deformation is not uniform, but is concentrated in bands of

macroscopic dimensions separated by undeformed portions, more slip-bands being formed as extension proceeds.

The theories hitherto put forward as to these characteristics of plastic flow are admittedly incomplete and diverge widely in their nature. The contrast between a brittle material and one which undergoes plastic flow, however, can be explained in a qualitative way. The cohesion of a brittle material depends upon the juxtaposition of certain atoms in the structure arranged in a definite way, and if this arrangement is destroyed the scheme of the crystal is broken down. In a metal, on the other hand, the metal ions are held together by the common free electrons. Any scheme of arrangement in which the metal ions are approximately equidistant and closely packed satisfies the main conditions for cohesion; the many alternative "phase structures" in alloys is evidence of this. Hence, when the metal is distorted the atoms can pass through a continuous series of transitional configurations without breakdown of the whole structure. Some such process must be taking place on a slip-band, and it leaves the structure less perfect than before.

What we should like to have, according to Professor Bragg, is more precise information about the atomic movements when slip is taking place. The conception of atomic planes slipping over each other is probably far too simple. All theories agree in supposing that some kind of dislocation appears at one point in the crystal and travels across it. But the nature of this dislocation is one of the problems before us. When the metal is severely cold-worked and has reached a state with characteristic mechanical properties, we may equally well ask what determines this final state, although various lines of evidence point to a mosaic of crystallites of dimensions 1-5 inside each crystal grain.

Aluminium Output in Central Europe

THE recent union of Austria and Germany will greatly affect aluminium production for the latter country, whose aluminium output already rose from 19,000 metric tons in 1933 to 130,000 tons in 1937. Even with this enormous increase over five years the 1937 output was insufficient to cover the total requirements of the country because other steps have had to be taken to increase the supply. For instance, the import duty on aluminium has recently been lifted until the end of March, 1939, and various works are being extended in the hope of raising the production capacity to about 150,000 metric tons per year before the end of the current year.

It is now intended to make use of the enormous hydroelectric power reserves of Austria for the large scale production of the metal. Austria has so far been an insignificant producer and her highest output did not exceed 4,000 metric tons per year. Negotiations have just been initiated between German interests and the "Oesterreichische Kraftwerke A.G.," however, with the object of increasing the company's aluminium works at Steeg. At present the capacity of these works is below 2,000 tons per annum; the intended future capacity exceeds 10,000 tons.

The potential output of the second Austrian aluminium factory at Lend, near Zell-am-See, which is controlled by the Swiss aluminium group, is also to be extended. In addition, plans for the erection of various new works with large capacity on former Austrian soil are to be carried into effect before the end of the year. Preliminary plans at present indicate that the potential output of aluminium in Austria is to reach the 50,000 tons mark before the beginning of 1940. Nevertheless, little advantage will accrue from Austria in respect of the primary raw material—bauxite.

Structure of Electro-Deposited Chromium

CHROMIUM normally crystallises in a cubic form, and the dimensions of the unit cube have been determined both for the pure metal and for chromium deposited on copper. The lines in the diffraction pattern given by the deposit are broad and diffuse, but a satisfactory method has been developed for comparing the dimensions of its crystal lattice with that of the normal metal. It is found that the former lattice is definitely greater than the latter. Ordinary annealing of the electro-deposit reduces the size of the cubic cell, but even after such treatment the deposited metal has still a larger lattice size than the normal chromium. In the case of bright deposits, the cube size has always a maximum value, whereas dull deposits are characterised by a smaller and more variable lattice. Results of investigations indicate that some of the gas deposited along with the chromium is intimately associated with the metal crystals. By changing the constitution of the electrolyte, the deposit can be obtained in a hexagonal instead of a cubic form. X-ray methods have been used to investigate this transition from the hexagonal to the cubic structure.

Nickel Alloys and Ammonium Salts

WITH an increase in the number of processes which now utilise solutions of ammonium salts, a closer knowledge of the corrosive effect of such solutions upon various constructional metals has become desirable. Some of the available data, which are very fragmentary and, in many cases, only qualitative in character, have recently been reviewed by L. F. Audrieth and T. E. Franks (*Metals and Alloys*, 1938, 9, 51). The tests reported were made in the course of a preliminary investigation of the resistance of some of the commoner alloys to liquid ammonia, and solutions of ammonium chloride, nitrate and thiocyanate. The immersion period was three months and the tests were made at room temperature. The materials tested comprised iron and iron alloys (including six austenitic nickel-chromium-iron alloys ranging in nickel content from 8 to 68 per cent., and iron-chromium alloys), copper-base alloys of various types (including nickel-silicon brass, a 64/30/5 per cent. copper-nickel-zinc alloy and an alloy containing copper 67, nickel 68, iron 5 per cent.), pure nickel, lead, and a 94/6 per cent. lead-antimony alloy. The high nickel-chromium and chromium steels proved quite resistant to attack by ammonium chloride and ammonium nitrate, but were readily attacked by the thiocyanate solution. The alloys of the copper group were attacked by all three solutions. Chemical lead was also heavily attacked, but the addition of 6 per cent. antimony was found to enhance resistance to ammonium chloride. Nickel, wrought iron and steel suffered appreciable corrosion by all three solutions. As pointed out by the authors, the results of this investigation emphasises the need for more extended research on corrosion, not only in ammonia solutions, but in other solvent systems where specific solutes impart peculiar chemical characteristics.

Recovering Pickling Acid and Iron Sulphate

Operation of the Kestner-Fakler Process

EVERY day thousands of gallons of weak spent sulphuric acid are run to waste in pickling plants. It is well known that spent acid contains ferrous sulphate and weak sulphuric acid, but in the past manufacturers have not installed plant to recover these chemicals because of the high capital cost and expensive operating charges associated with recovery plant.

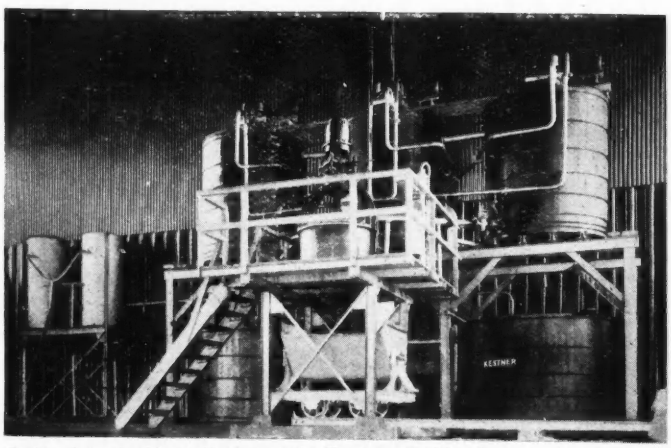
After investigation into the chemical and physical conditions which exist during acid pickling, a simple process has now been evolved whereby there is no loss of acid and the ferrous sulphate is obtained in fine crystalline form, ready for sale. The plant for operating the process is so simple that the use of an evaporator or refrigerator is entirely eliminated, and the process, moreover, is a continuous one.

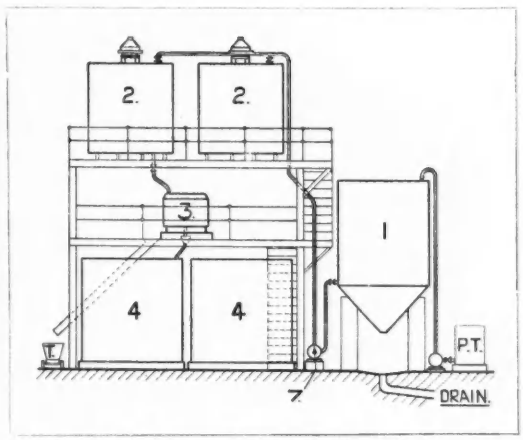
This Kestner-Fakler process, introduced by the Kestner Evaporator and Engineering Co., Ltd., can be applied to any plant pickling steel or iron parts using sulphuric acid, and has several unique advantages. There is high recovery of acid, with a loss of not more than 1 per cent., and also high recovery of ferrous sulphate in uniform crystal size ready for sale, all without the use of refrigerators, evaporators or other costly plant. In addition, the uniform acid strength results in less metal being wasted; there is low temperature of pickling acid and consequent saving in steam, the process is easily worked by unskilled labour; and no contamination of works effluent takes place.

The diagrammatic arrangement of a typical Kestner-Fakler plant is shown in one of the accompanying illustrations, where it will be seen that the main items comprise a settling tank (1), crystalliser (2), filter or hydro-extractor (3), a tank or tanks for recovered acid (4). One or more pumps may be required, according to the layout of the existing pickling tanks and the space available.

Method of Operation

Dirty acid from the pickling tanks (PT) is pumped or run by gravity into the storage and settling tank, where it is left for a minimum of two or three hours. The dirt, scale and other solids settle, leaving a clear green liquid which is drawn off by the pump (7) and passed to the crystalliser. Here ferrous sulphate crystals are formed, and the mixture is fed by gravity to a simple filter or hydro-extractor according to the size of the plant. The crystals are dropped into trucks or barrows (T), and carried away for storing or bagging. The clean acid is passed into the regenerating tank and diluted with water as required, and then returned to the pickling tank for further use. In installations of any size, it is arranged to heat the regenerated solution beforehand, so that it is ready to be used in the pickling tanks. No acid is lost, except the trace in the sludge drained from the settling vat, and this does not exceed 1 per cent.





Left: A typical installation of the Kestner-Fakler Process for recovering pickling acid and iron sulphate. Right: Diagrammatic arrangement of plant.

It is difficult to give a general statement as to the saving which may be expected, as there are a number of variable factors in every pickling plant, but it can be safely said that in all cases the savings are so great that the capital cost of the plant is soon paid off. An example, based on actual results, will illustrate this more clearly. One particular pickling plant handling steel strip had an annual consumption of acid amounting to 28 tons of 1.8 density acid for every 1,200 tons of steel strip pickled. By the adoption of the Kestner-Fakler patent recovery process, the acid consumption was reduced by 20 per cent. and at the same time the consumption of inhibitor was halved. A further saving was effected by the reduction in loss of steel, which amounted to quite an appreciable figure, taken over a year.

These savings may be summarised as follows: Saving in acid, taken at £5 15s. per ton, £380; saving in inhibitor, taken at £56 per ton, £28; saving in metal, £130; by sale of ferrous sulphate at £30 per ton, £600; making a total yearly saving of £1,138. This example, which is a typical one, demonstrates clearly the exceptional value of the Kestner-Fakler process to all firms who are engaged in pickling iron and steel with sulphuric acid.

The size of plant will vary according to the weight of metal parts to be pickled per year. There are two standard size units which fulfil most requirements. Working only six hours per week an installation can treat the spent acid from a factory which pickles 210 tons per week of moderately oxidised material, or 170 tons of highly oxidised material. Larger installations working three 8-hour shifts in twenty-four hours can deal with the spent baths corresponding to a pickling production of up to 1,600 and 1,350 tons per week respectively.

The settling tank, crystalliser and regenerating tank of the plant are made in keebush or other materials according to requirements. Keebush is a special non-metallic constructional material containing no rubber, which is completely resistant to the acids and iron sulphate mixtures; the life of such tanks is practically unlimited. Kesnter centrifugal acid pumps, as used by chemical works for acid pumping, are installed with Kestner acid valves on all pipelines.

PHOTOGRAPHIC PLATES treated with an aqueous solution of sodium salicylate acquire greater sensitivity to the ultraviolet (Kin, *Compt. Rend. Acad. Sciences*, 205, 704).

Assay of Gold in Cyanide Solution

Precipitation with Cuprous Chloride, Filtration, Fusion and Cupellation

FOR the determination of gold present in cyanide solution J. T. King and S. E. Wolfe, of the University of Toronto, Canada, have devised a precipitation method which is claimed to be superior to the lead-dish evaporation method. Details of the procedure have been published in a recent issue of the *Canadian Mining Journal*.

An exact number of assay tons of the cyanide solution is measured in a graduated flask and transferred to a beaker. The volume taken will depend on the accuracy required. For up to 20 assay tons, 10 cc. of fully reduced (clear) cuprous chloride are added. In excess of 20 assay tons, add 2 cc. more for each 10 assay tons, excess. Stir thoroughly and leave the rod in the solution. Allow a few minutes for complete precipitation of values (five minutes is ample), then filter through a 15-cm., No. 2 folded Whatman paper (or equivalent grade) which has been treated with filter paper pulp. Wipe the beaker interior, the lip (inside and outside) and the rod, with a moistened half sheet of filter paper; this ensures collection of all the precipitate. Place in the funnel. When the solution has completely drained, transfer the filter, apex down with its precipitate, to a 20-gram crucible which contains a little stock flux. To the open cone add the balance of the stock flux. Fuse, cupel and part as in an ore assay.

Preparation of Cuprous Chloride

The slow procedures recommended for the preparation of cuprous chloride and the lack of provision for keeping it in the fully reduced or "ous" state, have in the past been largely responsible for any unpopularity of the method.

Place a large excess of flattened copper wire, or strips of scrap sheet copper in a Winchester or in a glass bottle of suitable size. Fill the container with crushed copper sulphate and strong commercial hydrochloric acid, in the proportion of one $CuSO_4$ to three HCl. The copper should extend to the top of the bottle and expose a large surface of contact to the acid. Stopper the bottle tightly. Allow to stand until the solution is reduced to the chlorous state, when it will be clear and colourless. The time required varies considerably, according to the copper surface exposed and the temperature, but will be from several days to a week or more.

A quick and convenient way to bring about the desired reaction is to boil the mixture gently in the presence of excess copper, in a large Pyrex flask, fitted with a glass condenser at the top, through which water is flowing. In a few hours the solution is quite clear. Then, remove the condenser, stopper the flask tightly and allow the solution to cool. On cooling, the solution darkens, and being supersaturated, some Cu_2Cl_2 will crystallise out, but in an hour or two the solution again becomes clear.

Storage of Cuprous Chloride

As a substitute for the water-cooled condenser, one cooled by air may be used. Connect a one-inch diameter glass tube, five feet or more in length, to the top of the flask in a vertical position. Attach a safety thistle tube to the top and partly fill it with water. To provide for the escape of any fumes, connect the safety tube to the outside atmosphere, by old hose or glass tubing. To cool the condenser tube, surround it with a wooden box through which low-pressure air is blown. The former procedure, using a water-cooled condenser, is preferable, since condensation is more efficient.

This solution darkens quickly, due to oxidation, if exposed to air, thus diminishing its reducing power. Several methods were tried to eliminate this troublesome feature. The most satisfactory is to use hydrogen as a cover, and to syphon the solution from its container as required. Hydrogen is supplied from the Kipp charged with zinc and diluted hydrochloric acid. The gas inlet to the flask and the syphon are each provided with a glass stop-cock. The glass syphon should not be immersed into the solution until the latter is cool and clear. When many assays are done daily, large quantities of cuprous chloride should be made at a time, and by storing several bottles connected in parallel with the generator, no delays should be experienced. A litre of solution is sufficient for 100 assays, each on 20-assay tons samples.

Choice of Coagulant or Collector

The gold-copper cyanide precipitated by the addition of cuprous chloride to gold-bearing cyanide solutions is very finely divided and is pale green in colour. It has a decided tendency to pass in minute amounts through filter papers, especially at the beginning of filtration. To overcome this and otherwise facilitate filtering, general practice has been to add a small amount of weak potassium ferro-cyanide before filtering. This produces a copious chocolate brown precipitate which acts as an effective coagulant. However, if an excess of the salt, over and above that acting with cuprous chloride is used, gold will pass back into solution from the gold-copper cyanide. Creed and Cayton-Boxall, showed how serious this loss may be, in both the copper-sulphate and the cuprous-chloride methods. Whitby, the originator of the copper method, points out that the above re-solution occurs with the use of an excess of potassium ferrro-cyanide, and that the latter has no place in the method except as a coagulant.

Among other effective coagulants tried is sodium sulphide, five drops of a 10 per cent. solution. It rapidly forms copper sulphide and effectively collects the gold precipitate. As copper sulphide would not form in the presence of free syanide, its precipitation indicates that there was excess of cuprous chloride present and hence, that sufficient was present to precipitate the gold. On the other hand, the amount of sodium sulphide used should be low, as otherwise, an excessive amount of copper will go to the fusion, and in extreme cases may result in high slag and cupel losses.

Preparation of Filter Paper Pulp

As a mechanical substitute for the chemical coagulants, a filter-paper pulp is recommended. It is prepared readily as follows:—To scraps of filter paper in a beaker, add sufficient concentrated hydrochloric acid to wet them. Allow the paper to swell and digest for up to four minutes, then transfer it to a bottle. Dilute with water and shake thoroughly. The acid destroys the paper bond and vigorous shaking causes the non-coherent fibres to form a pulp. Before filtering the precipitate in the assay, pour sufficient of the well diluted pulp over the interior of the folded papers, to coat the whole surface with a pulp lining. This will ensure rapid filtration and minimise loss of the finest precipitate. As in any filtering operation, it is a good precaution to return the first few cc. of filtrate to the paper again.

Composition of Stock Flux

The stock flux is composed of silica 8 parts, borax glass 4 parts, soda carbonate 36 parts, litharge 40 parts, flour 1 part, or argol 2 parts. About 90 grams of the well mixed flux is measured out for each fusion. Parting silver is added as required. A No. 2 Whatman 15-cm. paper reduces about 10 gm. of lead, hence, the limited amount of reducer given in the flux. This flux gives good slags in furnaces where fusion is performed at around 1,000° C.

The method described has been given several years' trial on synthetic, pure, and impure solutions containing known amounts of gold and silver, as well as on pregnant and on barron mill solutions. It gives consistant checking results, as high as and in some cases higher than those of other methods, including the Chiddey, copper sulphate, litharge, and lead evaporation. Due to the simplified procedure, manipulation is very easy and, since large, as well as small amounts of solution may be taken for assay, the method has a wide range of application.

Oxidation Losses in the Cupola

Comparison of the Balanced Blast and Ordinary Design

By L. W. BOLTON, A.M.I.Mech.E.*

IN an article entitled "Foundry and Steel Works Cupolas," by Poumay, jun. (*Revue de Fonderie Moderne,* August, 1937, p.10) reference is made to the balanced blast design of cupola. The author states that in this cupola the air supply is controlled at the main tuyeres only, but no mention is made of the fact that the amount of air admitted through the auxiliary tuyeres is controlled also. This is an important point in the operation of this type of cupola, as it is the adjustment of the air admitted through the main and auxiliary tuyers that enables the most efficient working of the cupola to be obtained. The correct balance between primary and secondary air is obtained during the trial melts, and, under normal conditions, gives almost complete combustion of the carbon in the coke.

M. Poumay examines an analysis of the exhaust gases from a balanced blast cupola, and claims that from this it is possible to show that the balanced blast type of furnace is 4.24 times more oxidising than a cupola of normal design. The gas analyses that M. Poumay criticises were published in the *Iron Age* for May 21, 1936, and were as follows:

	Normal Cupola.	*B.B. Cupola.*
CO_2	12.30	18.30
CO	10.05	1.21
O_2	0.37	0.54
N_2	77.28	79.95

This figure was incorrectly given as 79.75 in the *Revue de Fonderie Moderne*, March 25, 1937.

The two furnaces from which these analyses were taken have a melting rate of 14 tons per hour and were originally identical, one having been converted to the balanced blast system. Both produce metal of the same temperature, the converted cupola using a metal to coke ratio, including the bed, of 13.3 : 1 (7.5 per cent.) and the unconverted furnace 9.1 : 1 (11 per cent.). These gas analyses were averages obtained from a large number of determination.

In comparing the oxidation in the two types of cupola, M. Poumay examines analyses of the top gases from the balanced blast cupola, but calculates the oxidation in the normal cupola by assuming certain losses of silicon and manganese from the metal. This method of comparison is obviously incorrect and gas analyses from the two types of furnace should be compared, or failing this, the losses of the elements during melting should be compared in both types.

M. Poumay assumes that in a normal cupola, losses of silicon and manganese are 15 per cent. and 20 per cent. respectively, and the total loss of metal by oxidation is 1.2 per cent. It can be stated quite definitely that it is impossible to estimate the total melting loss with the accuracy required for a calculation of this type, as allowance must be made for so many factors which will influence the result obtained. These factors include sand on pig iron, rust on scrap, errors in weighing the charges, metal left in the cupolar drop and lost in the slag, skulls in ladles, splashings, etc. The British Cast Iron Association has records of a large number of estimations of the losses of silicon and manganese occurring in the balanced blast cupola. These naturally vary with the type of charge used, the temperature of metal required and the amounts of the elements present. It can, however, be stated that in the balanced blast cupola, melting metal of the analysis put forward by M. Poumay, losses of silicon and manganese are, under normal conditions, lower and certainly not higher than those given for the ordinary type of cupola.

As stated above, if comparison of the oxidation which takes place in cupolas, is made by examination of the exhaust gases, the same method should be used in both the ordinary and the balanced blast cupola. Examining the analyses of the gases from the two cupolas given above, the amount of oxygen supplied to the furnaces may be estimated from the nitrogen figures, as follows:

In 100 cu. ft. of air there are 21 cu. ft. of oxygen and 79 cu. ft. of nitrogen. From this it is possible to estimate the amount of oxygen entering the furnaces to produce 100 cu. ft. of exhaust gas, of the analyses given above.

Normal Cupola. $\frac{21 \times 77.28}{79} = 20.54\ O_2$ *Balanced Blast Cupola.* $\frac{21 \times 79.95}{79} = 21.25\ O_2$

The actual oxygen content of 100 cu. ft. of the exhaust gases may be estimated as follows:—

Normal Cupola			*Balanced Blast Cupola*		
12.3 % CO_2	contains 12.3 cu. ft.	O_2	18.3 % CO_2	contains 18.3 cu. ft.	O_2
10.05% CO	„ 5.02 „	O_2	1.21% CO	„ 0.6 „	O_2
0.37% O_2	„ 0.37 „	O_2	00.54% O_2	„ 0.54 „	O_2
	17.69 „	O_2		19.44 „	O_2

It wili therefore be seen that the oxygen which enters the cupola but which does not leave in the exhaust gases, is as follows:—

Normal Cupola. $20.54 - 17.69 = 2.85$ cu. ft. O_2 *Balanced Blast Cupola* $21.25 - 19.44 = 1.81$ cu. ft. O_2

To produce 100 cu. ft. of exhaust gas the amount of air supplied to the two furnaces must be as folows:—

Normal Cupola.		*Balanced Blast Cupola.*	
N_2 = 77.28 cu. ft.		N_2 = 79.95 cu. ft.	
O_2 = 20.54 „		O_2 = 21.25 „	
97.82 „		101.25 „	

so that in the case of the normal cupola, from 97.82 cu. ft. of air, 2.85 cu. ft. of oxygen are lost, and in the balanced blast design only 1.8 cu. ft. of oxygen are lost from 101.25 cu. ft. of air. This shows that the amount of oxygen lost as the blast passes through the normal cupola is 1.64 times greater than in the balanced blast cupola.

M. Poumay in his calculations, assumes that a proportion of the carbon dioxide in the exhaust gases is derived from the limestone and estimates this as 1 per cent. carbon dioxide. Making a correction for this in the above figures, the oxygen lost in the normal cupola is 1.44 time more than in the balanced blast cupola. If it is assumed that this oxygen is taken up in oxidising the metal then the normal cupola is at least 1.4 times more oxidising than the balanced blast cupola.

Analyses of the exhaust gases from a cupola are primarily intended to give an indication of the efficiency of combustion by showing the relative amounts of carbon dioxide and carbon monoxide present and from this standpoint they can be of value when an investigation is being made into the efficiency of a furnace.

On the other hand, however carefully the gases may be sampled and analysed there are so many sources of error due to the constantly changing conditions in the furnace and the difficulty of obtaining truly representative samples that it is very doubtful whether the results obtained can serve as a reliable guide to the amount of oxidation taking place in the metal.

*Reprinted from the Bulletin of the British Cast Iron Research Association, May 1938.

Some Recent Metallurgical Patents

Annealing Alloys

Magnesium alloys contain 2-12 per cent. of aluminium, 4-12 per cent. of tin, and 0.5-12 per cent. of silver with or without up to 2 per cent. of manganese, up to 3 per cent. of zinc, cadmium, antimony, arsenic, bismuth, and lead, and up to 1 per cent. of silicon and copper. Minor amounts of boron, chromium, titanium, cerium, and thorium may also be present. The maximum total of aluminium, tin, and silver is 20 per cent. The alloys may be heat-treated for about 20 hours at 450° C., followed by treatment at 130-350° C., for example at 250° C. for 15 hours. (See Specification 477,721, of High Duty Alloys, Ltd., and W. E. Prytherch).

Desulphurising Steel

In the desuphurisation of steel by means of alkalies such as soda or potash, sufficient alkali is added to the molten bath so that the slag covering the molten metal is super-alkalised, thus ensuring that further sulphur is absorbed by the slag during a dead melt period after the finish of the heat. The process described above may be applied to the manufacture of steel by the basic bessemer or Thomas process, or the basic open-hearth or electric processes, and may also be applied to the acid processes. When carrying out the basic bessemer process, the alkali addition may be made before, during or after the blowing operation and is preferably made in two portions, the first at the beginning of the blow and the other after the blow, and the heat is held after the finish of the blow to allow further desulphurisation by the alkali. If the amount of manganese in the iron to be treated in the basic bessemer and other processes is insufficient, the sulphur present in the iron is largely removed before the addition of the required amount of manganese, preferably in the form of molten ferro-manganese, is made to the iron. (See Specification 474,282, of H. A. Brassert and H. A. Brassert and Co., Ltd.).

Niobium in Alloys

A small proportion of niobium is added to aluminium alloys, particularly those containing copper or nickel or both, with or without magnesium, and with or without silicon and iron. The alloys may contain 0.5-12 per cent. of copper, 0.5-5 per cent. of nickel, 0.1-3 per cent. of magnesium, 0.2-2.5 per cent. of silicon, 0.2-2 per cent. of iron, and 0.05-1 per cent. of niobium. The niobium may be introduced in the form of an aluminium-niobium alloy made from ferro-niobium by melting with aluminium to form an alloy containing 5 per cent. of iron and 5 per cent. of niobium, other preliminary alloys employed being aluminium-nickel with 20 per cent. of nickel, aluminium-iron with 10 per cent. of iron, aluminium-copper with 50 per cent. of copper, and aluminium-silicon with 20 per cent. of silicon. Magnesium is added as metal. Forgings of the alloy may be heat-treated for example at 530° C. for 4 hours, quenched, reheated at 165° C. for 10 hours, and quenched. (See Specification 474,757, of J. Stone and Co., Ltd., A. J. Murphy, and S. A. E. Wells).

Iron Containing Titanium

Iron with a titanium content exceeding 0.6 per cent. is produced in a coke blast-furnace by the use of a basic slag of which calcium aluminates constitute more than 50 per cent. A furnace temperature of 1,600° C. or more, preferably one of 1,800° C. or over, is employed. Bauxite, containing titanium dioxide, is preferably employed for the charge, in which case titanium ores such as ilmenite or rutile need be added only to a small extent or not at all. As the iron content of bauxite is low, another source of iron, preferably scrap iron, may be added. Large quantities of slag, which may amount to three times the quantity of iron, are employed. In an example, the mixture consists of 3,000 kilograms of bauxite, 300 kilograms of ilmenite, 3,750 kilograms of scrap, and 3,000 kilograms of limestone. In a further example, the mixture contains no ilmenite, and consists of 3,000 kilograms each of bauxite and limestone and 1,700 kilograms of scrap. (See Specification 477,935, of Hochofenwerk Lubeck A.-G.).

Refining Metals

In the refining of metals, and more particularly electrolytic copper, the metals are first heated in an electric radiating furnace to 900-1,000° C., so as to avoid melting whilst protecting them from the atmosphere until the major part of the occluded hydrogen has escaped, the metals being afterwards melted in the same furnace and then cast immediately while protected from the action of the atmosphere. When treating copper cathodes, they are placed on charcoal in the furnace before being heated. Other metals such as iron, cobalt nickel and aluminium may also be refined in the same manner. (See Specification 480,107, of W. W. Triggs, Soc. Generale Metallurgique de Hoboken).

Beryllium Alloys

Beryllium is extracted by heating a preformed initially solid mixture of beryllium chloride and magnesium to a suitable reaction temperature, preferably 730,900° C. The mixture may be introduced either into an empty crucible or into a fused residue from a previous operation, and the reaction may be carried out in hydrogen. The mixture may also contain other chlorides such as those of potassium, sodium, or magnesium. The beryllium obtained may be separated from the reaction residues and compressed to coherent form, or melted in vacuo and heated in hydrogen. Beryllium alloys may be formed by including in the reaction mixture a metal, for example copper. (See Specification 480,787, of W. H. A. Thiemann, I. G. Farbenindustrie).

Coating with Metals

A thin zinc coating is formed on articles in known manner by pickling, cooling, immersing in a bath of zinc chloride as flux, drying in an oven, and then dipping in a molten zinc bath which may contain aluminium to increase its fluidity, and, immediately after coating, the edges, folds, grooves, or other portions where there is a break in the continuity of the surface are coated with colourless lacquer to prevent corrosion. The lacquer is preferably applied by spraying. (See Specification 480,578, of Hutten-Werke Siegerland A.-G.).

Heat Treating Aluminium Alloys

In a process for heat-treating aluminium base alloys containing 3-16 per cent. of magnesium and a total quantity of 0.5-5 per cent. of at least one of the metals chromium, iron, titanium, vanadium, tungsten, cobalt, and nickel, adapted to form hard compounds with aluminium for the purpose of rendering them suitable for working with high speed cutting tools, the alloys are subjected to heat treatment within a temperature range lying between 300° C. and the melting point of the most easily fusible constituent of the alloy, for a period requisite to bring about a sufficient disintegration of the primary crystals of the hard compounds so that a smooth surface is obtained when the working the alloy with the high speed tools. Manganese may also be present in the alloy in an amount lying between 0.5 per cent. and 5 per cent. along with the other additional metals. The heating may be preceded by a heterogenising heat treatment at temperatures below 300° C. and may be followed by plastic deformation. (See Specification 480,746, of W. H. A. Thiemann, I. G. Farbenindustrie).

Corrosion Resistant Alloys

Corrosion resistant alloys particularly for making pumps, valves, pipes, and other parts of chemical apparatus consist of 50-55 per cent. of nickel, 20-30 per cent. of chromium, 2-12 per cent. of iron, less than 0.3 per cent. of carbon, less than 1 per cent. of manganese, up to 5 per cent. of silicon, up to 6 per cent. of molybdenum, up to 3 per cent. of tungsten, and up to 7 per cent. of copper. The alloy may be made by charging a furnace with low carbon steel and adding in succession chromium as ferro-chrome, copper and nickel partly as an alloy and partly as free nickel, and then the remaining ingredients while the bath is protected by a slag. The product is treated with a scavenger and poured into moulds. (See Specification 481,105, of H. E. Labour).

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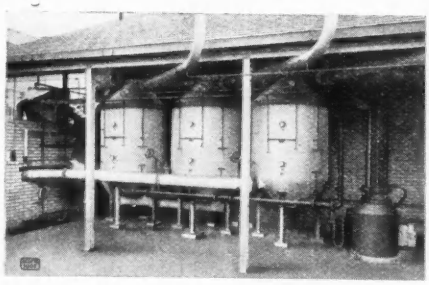

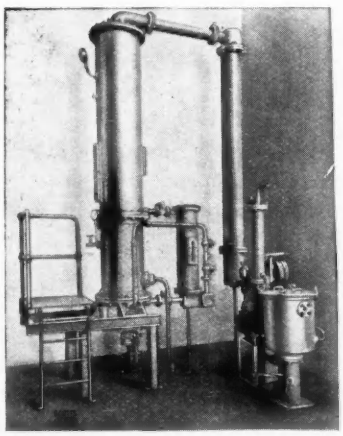

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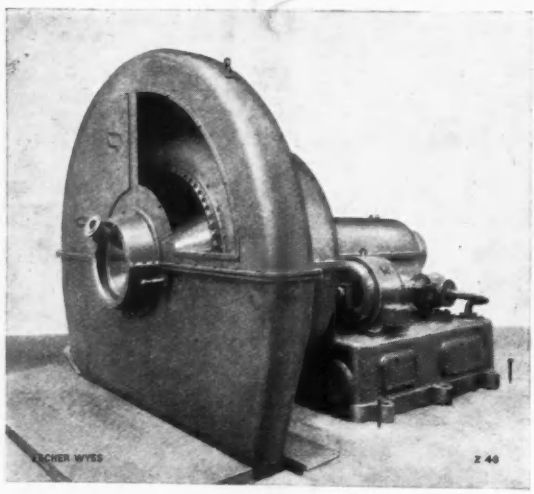

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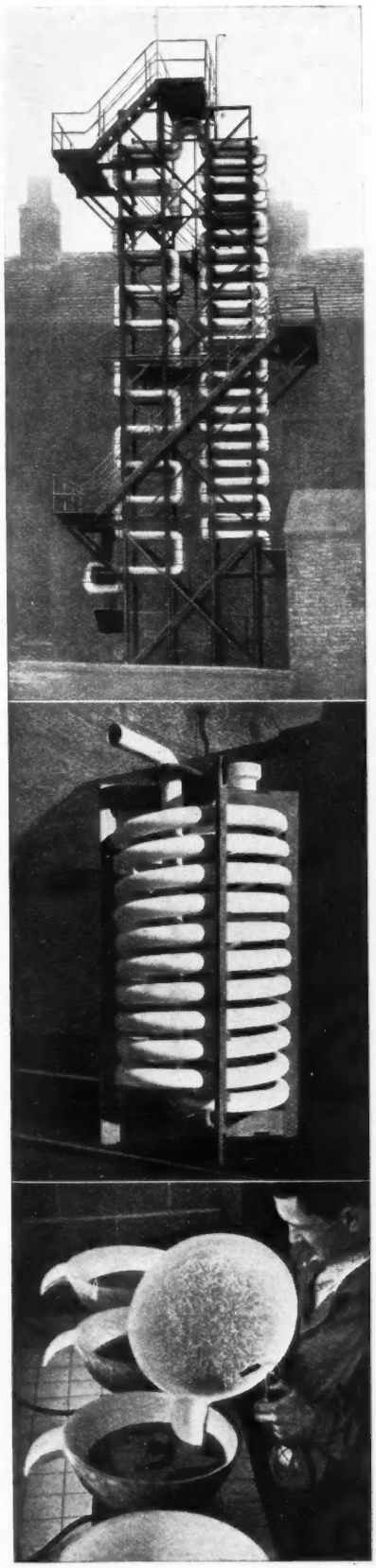

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WALWORTH Service Bulletin

No. 6 VOL. II. JUNE, 1938

Inter Office Memo

Date 10th June, 1938.

From THE MANAGING DIRECTOR'S OFFICE.

To THE PLANT MANAGER.

Subject THE FACTORIES ACT 1937.

THIS COMES INTO FORCE 1st JULY 1938.

NOTE SECTIONS 12 to 16 RE FENCING OF MACHINERY.

18 RE FENCING OF VESSELS CONTAINING DANGEROUS LIQUIDS.

25 RE OPENINGS IN AND AROUND FLOORS, PASSAGES, GANGWAYS, STEPS, STAIRS AND LADDERS.

26 RE PRECAUTIONS AGAINST FALLS.

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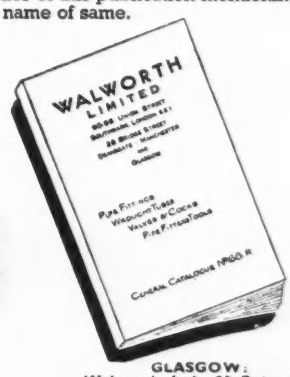

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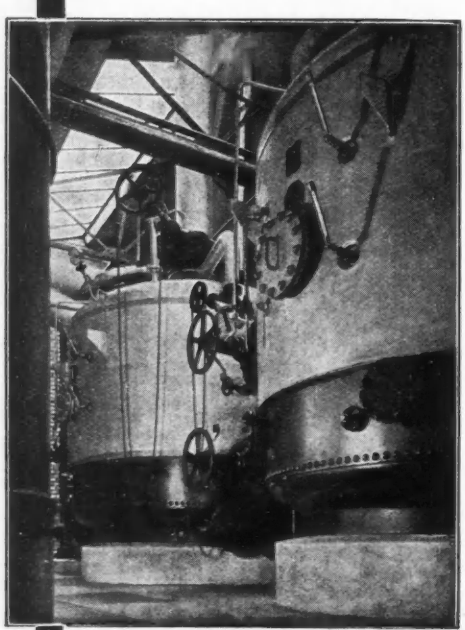

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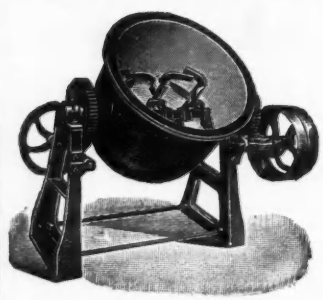

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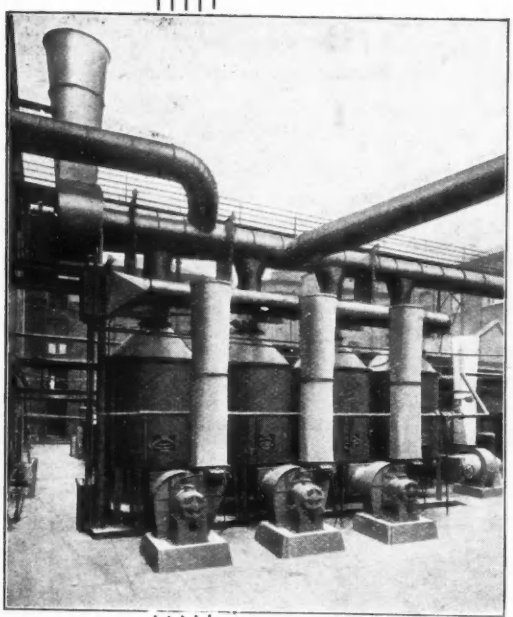

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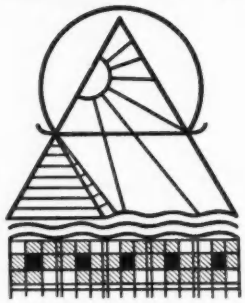

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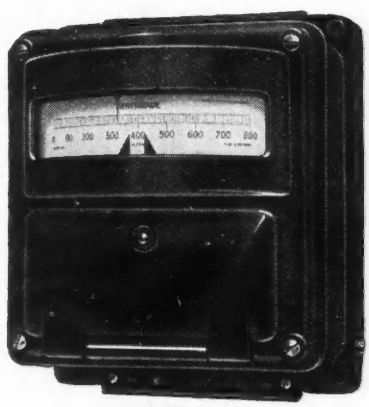

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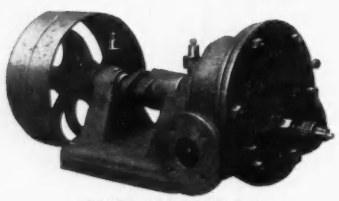

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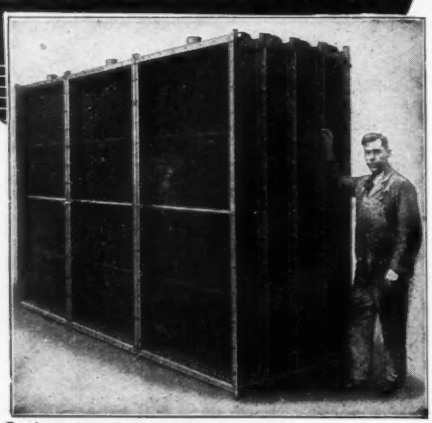

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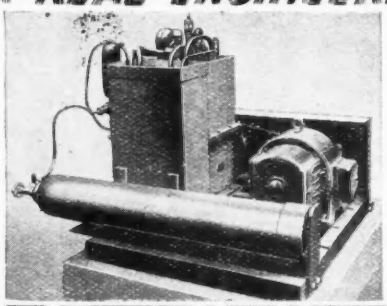

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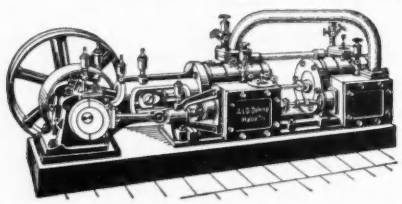

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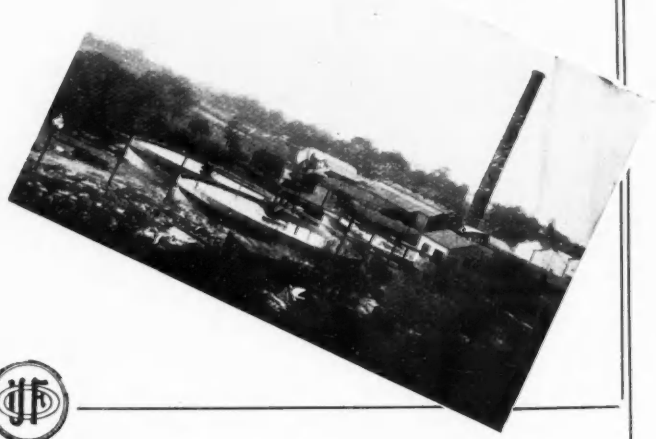

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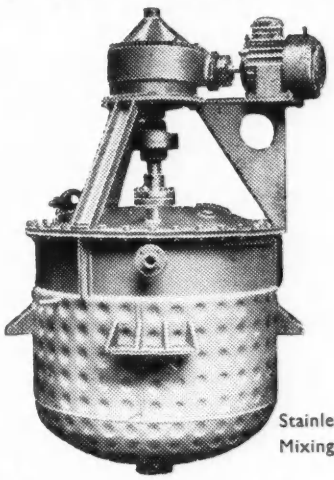

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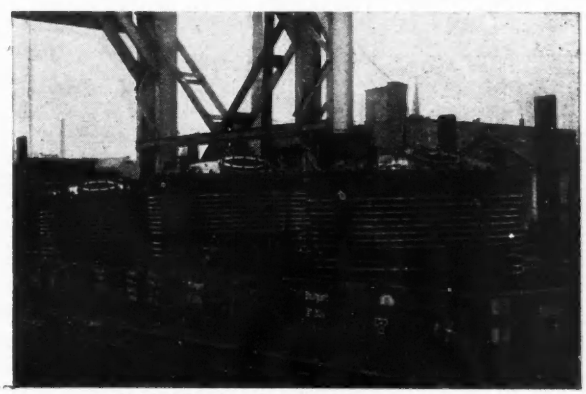

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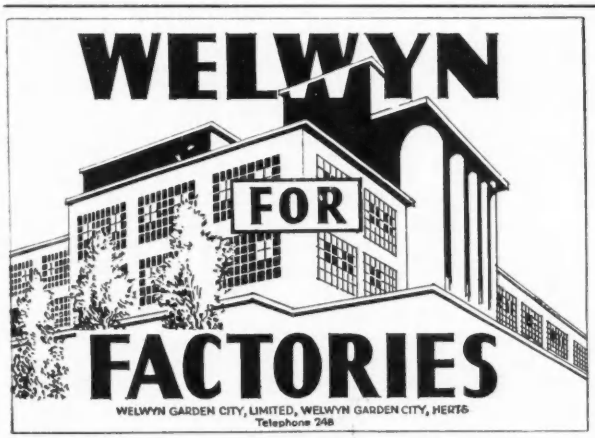

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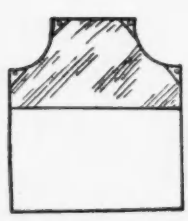

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